BANGALOREWATERSUPPLY AND SEWERAGE BOARD

5thFloor,CauveryBhavan“D”Block,
K.G.Road,Bangalore560009

Tenderforthe:EstimateforProvidingAndLaying1000/1200/1800/2000 mmDiaRCCNP- 3 Class Sewer Line from 7th Main Garvebhavipallya along HSR Layout upto agaram STP and construction of ISPS at HSR Layout under AEE(WWM-N) K&T Sub Division at Various Location.

(ThroughKarnatakaProcurementPortal only)

https://www.kppp.karnataka.gov.in

OfficeoftheChiefEngineer(WasteWaterManagement-East) BANGALORE WATER SUPPLY & SEWERAGE BOARD

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VOLUMEII

SECTION 7

TECHNICALSPECIFICATI

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PART 1

PROJECT

INFORMATION

PART 1

PROJECTINFORMATI

ON

BWSSBK&TValleyDivision

This project deals with the preparation of Detailed Project Report, Bid Document for addressing the problems in the sewerage network of sewers having diameters of 450 mm and above in the K&T valley of the core city of Bengaluru.

a) The major sewers form two main branches. The northern branch originates in Siddapura as a 450mm sub-main, increases to 600mm diameter in Byrasandra, with a further increase to 900mm diameter in Laxmipura. A 450mm diameter sub-main serving 9th Block Jayanagar connects into the 600mm / 900mm sewer in Laxmipura**.**

b) The second branch, to the south, originates in 5th Block Jayanagar as a 450mm diameter sub- main and changes quickly to a 900mm diameter sewer before going through JP Nagar. Near Kaverrappa Road,onthe west side ofMadiwala Lake, an 4MLD STP at Madiwala has recently been constructed, its purpose being to rejuvenate Madivala Lake. Sewage flows to this STP are drawn off the 900mm diameter sewer which is routed along the west side of Madiwala Lake before joining the north branch 900mm diameter sewer on Hosur Road. A 1800mm diameter sewer has been constructed from there, via HSR Layout, to Agaram ISPS.

c) The 1000mm diameter sewer is heavily silted for approximately 3 km of its length from Hosur road to the ISPS, and has not delivered sewage for a number of years.BWSSB operate a diversionofflows into a drainage channel linked to Bellandur Lake.Tocompensate for loss of flows from the 1000mm diameter Tavarekere Valley sewer, BWSSB arranged for diversioninto the ISPS of nearbyprimarydrainage channel flows (which in the dryseason constitute raw sewage).

d) Sub-main sewers of 450mm and 600mm diameter serve 7th Block Jayanagar, this 5 km long sub-branch joining the 900mm diameter sewer from5th Block Jayanagar at Bannerghatta Road.

e) Hulimavu lake area Sub-main sewers starts with 600mm,700mm,900mm and 1000 mm is connected to existing 1800 dia pipe line near Madivala lake bund, at present in Hulimavu 10 MLD STP is Running and Sewage is comming from Nobanagar and Gottigere area and Agarm 35 MLD STP is Running and sewage coming from HSR and Parts of Agaram Area.Seeing the existing flow in storm water drain more than 50 to 60 MLD, at present

we have constructed 40 MLDadditional flow according pumping station proposed.

f) As per NGT O.A No.606 to mitigate the gap in sewage treatment the above work has been proposed.

LocationandDescriptionoftheWorks

LocationoftheWorks

TheWorksconsideredareasfollows;

S.No.	WorkName	Proposedϕ(mm)	Proposed Length(m)
1	**Estimate for ProvidingAndLaying 1000/1200/1800/2000mm Dia RCC NP-3ClassSewerLinefrom7th Main Garvebhavipallya along HSR Layout uptoagaramSTPandconstruction of ISPS at HSR Layout under AEE(WWM-N)K&TSubDivisionat VariousLocation.**	300	17160
2		900	3073
3		1200	1529
4		1600	1424
		1800	1898

ThedetailedlocationisshownontheDrawing.

DescriptionoftheWorks

TheWorksshallcompriseofconstructionforProvidingandLaying **1000/1200/1800/2000mm**DiaRCCNP-3ClassSewerLineinK&TValley.

TheWorksunderthiscontractshallincludebutnotbelimitedtothefollowing:

- Civil works of trunksewer of about 8.4kmwith the diameter range 900/1200/1400mm in K&T Valley Area
- Miscellaneous civil works, for site development works such as river crossing bridge,site grading, trenchless work, road works, pavement, temporary works required for all the alignment above.

FundingAgency

FundsforthecontractarebeingprovidedbytheGovernmentofKarnataka and BWSSB

AdditionalScope

Inadditiontotheabove,thefollowingservicesareincludedinthescopeoftheContract:

(a) Supplyofspecifiedmandatoryspareparts,whereverapplicable.

(b) Supplyofspecifiedstandardandspecialtools.

(c) Furnishingofdrawings,documents,operationandmaintenancemanual.

It is not the intent to specify completely herein all details pertaining to design, shop testing, installation, field testing and commissioning. However, these shall conform in all respects to high standards of engineering design, workmanship, meeting the requirementsofallapplicablecodesandstandardsincludinglocalstatutory

requirements. The Employer shall have power to reject any work or material which in his judgement is not in full accordance therewith.

GeneralInformation

Civil

Thefollowingsiteconditionsshallgenerallyapply:

MaximumTemperature	36°C
MinimumTemperature	11°C
MaximumRelativeHumidity	75%
MinimumRelativeHumidity	28%
Altitude	Asperrespectivedrawings
AverageAnnualRainfall	844 mm
SeismicZone	ZoneasperIS1893
ApproachRoad	CityRailwayStation
NearestAirport	KIAL,Bangalore
NearestRailwaystationfor:	CityRailwayStation,Bangalore

Electrical

NotApplicable

Geo-technicalInformation

Geotechnicalinvestigationreportforthe6sitesisavailableatBWSSB’soffice.TheBoard acceptsnoresponsibility,whatsoeverforinferencesdrawnfromthisdataandtheContractor is deemed to have satisfied on his own responsibility as to the extent to which this information represents the conditions to be encountered.

EndofPart1

PART -

2

THESIT

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PART -

2

THESIT

E

Locationofthework

Thelocationoftheworksisasindicatedbelow:anddetailsofsitelocationareshownondrawings.

Sl no	Work Details
1	**EstimateforProvidingAndLaying1000/1200/1800/2000mmDia RCCNP-3Class SewerLinefrom7thMainGarvebhavipallyaalongHSRLayoutuptoa garamSTP and construction of ISPS at HSR Layout under AEE(WWM-N) K&T Sub Division at Various Location**

Accesstothe Site

ThemainaccesstotheproposedsiteisHSRLayoutandJPNagar.

AreasOutsidetheSite

In the event of the Contractor making use of any special or temporary wayleave or accommodation acquired by him or any tip for the disposal of surplus materials, or any borrow pit or quarry, he shall obtain the written consent of the owner, occupier or authority having charge of the land in which such wayleave, accommodation or tip is situated and shall make a record agreed by the owner, occupier or authorityasaforesaidoftheconditionofthesurfaceofthatlandbeforeenteringthereon.

The Contractor shall permit the Employer and the Engineer and any person authorised by the Employer or the Engineer access for the purposes of the Contract to any such special or temporary wayleave or additional accommodation.

In the event of the Contractor making use of any special or temporary wayleave or additional accommodation made available to him by the Employer for the purpose of the Contract, the land in which such wayleave or accommodation is situated shall be deemed to be part of the site.

The Contractor shall restrict his activities to within the working area to be approved by the Engineerafter the Contractor submits the proposal for the same. On completion of the works in this area, the Contractor shall reinstate the area to its original condition to the satisfaction of the Engineer.

For the purposes of this Clause, `accommodation' shall be deemed to include housing, offices, workshops, warehouses, and storage areas.

Road Works

The Contractor shall obtain the Engineer’s permission for carrying out works such as excavation on the existing roads. The Contractor shall be responsible for

establishing and maintaining temporary road diversions for the duration of the road works. The road shall be kept open at all times during the road works period and the work shall be carried out in such a manner as to minimize the disruption to execution of other Contractor’s works.

MaintenanceofExistingAccessRoads

The Contractor shall only use existing access roads within the Site boundary which are necessary forthe execution of the Works. The Contractor shall obtain the Engineer's approval in writing before utilizing existing access roads within the Site. Once the Engineer's approval has been given the Contractor shall be solely responsible for the maintenance of the existing site access roads. This responsibility shall continue until the completion of the Defects Liability Period, or until such earlier dateastheEngineermayadvisetheContractorinwriting.Suchmaintenanceworkshallincludegeneral up-keeping and any necessary repairs to damaged road surfaces, pavement, drainage, associated slopes, etc to a standard, no worse than the original condition. While carrying out such maintenance work, the Contractor shall make arrangements to maintain through passage for the Employer's and his staff's vehicles and also those of other contractors over these access roads, which may comprise temporary diversions, all to the approval and satisfaction of the Engineer.

The Contractor shall not run tracked or unsprung vehicles on surfaced roads without the written approval of the Engineer who may require that planking or some other protective material be used to protect the road surface.

The contractor shall provide Liquid waste handling vehicles, fire and rescue vehicles, and allied equipment like Vacuum Pumps, Multi- pressure pumps, Portable as well as vehicle mounted fire/dewatering pumps, and Split shaft Power take-off (PTO) units

ClearanceoftheSite

TheContractorshallcleartheSitetotheextentrequiredbytheEngineerforcheckingthesetting-out.

Clearance of the Site shall also include the demolition and removal of all articles, objects, trees, shrubs and obstructions which are expressly required to be cleared.

The Contractor shall ensure that the parts of the Site to be occupied by the Permanent Works are clear and shall maintain the remainder of the Site as may be required for access and Temporary Works areas.

TheContractorshallremove the material arisingfromsuchclearanceanddisposeitoff in amanner and at a location, on or off the Site, to the approval of the Engineer.

The Contractor shall fill and make good with appropriate materials those cavities and losses of soil which result from clearing the parts of the Site not subsequently to be occupied by the Works.

The Contractor shall not clear the Site of any structure without the prior written permission of the Engineer.

ClearanceandReinstatementoftheSiteon Completion

On completion of the Works, the Contractor shall clear any temporary works areas and temporary access roads and reinstate the areas to their original

condition and to the satisfaction of the Engineer.

SiteRecords

TheContractorshall make recordsofthepositionandextentintheexcavationsofeverytypeofservice, stratum and obstruction encountered during the construction of the Works.

AccessfortheEmployerandEngineer

The Contractor shall permit the Employer and the Engineer and any person authorised by the Employer or the Engineerincludingworkmen of the Employer,other contractors orutilityundertakings access for the purposes of the Contract to all areas of the Site and to any additional accommodation or temporary wayleave for the duration of the Contract period.

PermissionfromServiceAgencies

The Contractor, who is the sole responsible to get the necessary permission from service agencies, such as, BBMP, BDA, Traffic Police, KPTCL, etc. the delay in getting the permission will not be taken into account.The contractor shall obtain the Engineer’s permission for carrying out the works such as, excavation on the existing roads, Employer will assist contractor to issuing the letter to the concerned department, if necessary.

WaterSupplyatSiteandWastewaterDisposal

Watersupplyforthepurposesofconstructingtheworksandtestingofthepipealignmentsh allbearranged by the Contractor at his own cost.

Wastewater shall be disposed off clear of the Site to the satisfaction of the Engineer so as to cause no damage or complaint.

SanitaryandWashingFacilities

Throughout the period of construction of the Works the Contractor shall provide, maintain and cleanse suitable and sufficient latrines and washing facilities for use by his employees. He shall ensure that his employees do not foul the Site but make proper use of the latrines.

Where practicable the latrines shall be connected to the nearest sewer, or if this is not practicable the Contractor shall provide an adequately sized septic tank and soakpit.

TheContractorisalsotoprovideseparatelatrinestotheaboverequirementsforalltheEngineer’sstaff .

After Completion the latrines and washing facilities shall be removed, all ground disinfected and the surface reinstated to the satisfaction of the Engineer.

ElectricityforContractor'sUseonSite

The Contractorshallbe responsiblefortheprovision and distribution ofan electrical supplyfor the purpose of constructing the Works.

The installationshall complywith all the relevant regulations,Indian Standards and Codes of Practice, and Health and Safety requirements, etc. The Contractor must take every possible precaution to ensure that his installationissafeandinjurytopersonnelordamagetoplantandbuildingsisavoided.TheC ontractorshall be fully responsible for all safety aspects.

The Contractor shall test the temporary site distribution system every 3 months for compliance with the relevant standards.

Worksinthevicinityof ElectricalEquipment

Any permanent fencing or other safeguards required to be erected around electrical equipment shall be completed as far as practicable before connection is made to the electricity supply. Where this is not practicable, the Engineer may permit the use of temporary fencing or other safeguards.

RefuseDisposalonSite

Refuse and rubbish of every kind shall be removed from the Site and disposed off by the Contractor at his own expense, frequently and regularly so as to keep the Site in tidy condition to the satisfaction of the Engineer.

Noise

The Contractor shall ensure that the operations entailed in the construction of the Works do not cause annoyance to others working on the Site or to persons living adjacent to the Site.

WarningandSafetySigns

During construction of the Works statutory safety signs, shall be adequately provided throughout the Works, both indoors and outdoors. These safety signs shall cover mandatory, prohibition, warning, emergency, fire-fighting and general notices. All signs shall be positioned around the Works at highly visible points. Provision of signs, and the positions of signs shall be subject to the Engineers approval. Special attention shall be given to areas designated hazardous. (as per IS-8989)

SiteWorkingHours

The proposed Site working hours shall be notified by the Contractor for Engineer’s approval. The Contractor shall not vary or increase the working hours without the prior approval of the Engineer.

ContractSignboards

The Contractor shall supply and erect signboards at his own cost at locations to be specified by the Engineer. The layout and dimensions of the signboards and their construction shall be to the approval of the Engineer and theletteringin bothKannada and English shall be black on a white background.

Advertising

The Contractor shall not use any part of the Site for any form of advertising without the prior written approval of the Engineer.

Protectionof Trees

Treesdesignated bythe Engineershallbeprotectedfromdamage duringthe course ofthe workandearth level within one meter of each such tree shall not be changed. Where necessary, such trees shall be protected with temporary fencing. All such cost shall be borne by the Contractor.

EndofPart 2

PART - 3

ENGINEER’SREQUIREME

NTS

PART3

ENGINEER'SREQUIREMENTS

Office

A separate Engineer's office for the sole use of the Engineer and his staff shall be provided by the Contractor for this contract at location identified by BWSSB. The Contractor shall provide, erect, furnish, clean, maintain and subsequently remove the office after the completion of works at the instruction of the Engineer. The proposed office building shall meet the following minimum carpet area requirements:

(a)	EngineeringRoom	- 2Nos.,10mx8m eachwithattac hed toilet
(b)	EngineeringRoom	-1No.,5mx5m
(c)	ComputerRoomwithAirConditioner	1No.3mx3m
(d)	Toiletswithwashbasin	-1Nos.1.5mx2meach

Thewallsshallbeof230thickbrickmasonry,plasteredandwithoilbounddistemper ontheinner faceandsnowcemontheouterface.ACsheetroofingwith6mmthickhardboardfals eceilingat3 meter from floor, painted with oil bound distemper shall be provided. The doors shall be of first quality wood and steel windows of approved quality shall be provided. The flooring for the office building shall be minimum 2.5 mm thick Vinyl flooring over PCC base. Before commencing the constructionoftheoffice,theContractorshallsubmittotheEngineerforhisapprov aladrawingof the proposed building with all architectural and finishing details fully shown. The location of the office shall be as directed by the Engineer.

The Engineer's office should be ready in all respects within 60 days of handing over the site. The Office shall be maintained throughout the contract period and defect liabilityperiod there on with office boy, power, water and housekeeping. Power and water supply shall be arranged by the Contractoreitherwiththeavailableresourcesorfromindependentsources(likeD Gsets,borewells, etc.) at his own cost.

The Contractor shall furnish the rooms as the Engineer directs and the equipment, furniture, furnishings and fittings to be supplied shall be of approved make and include the following at each site.

(a) 10Nos.of5'x3'tablewithbothsidedrawers(3oneachside)
(b) 2No.of3'x2'tablewithsinglesidethreedrawers
(c) 20chairs(approvedmake)excludingchairsforComputerandConference
(d) 3Nos.ofSteelcupboards(Storeweltype)
(e) 2Nos.-4DrawersFilingCabinet
(f) Curtainstoall windows

(m) ComputerTableandChair
(n) BrandnewpersonalcomputerandLaptopwithfollowingfeaturesincludingUPSof500VA:

- Pre-loadedwithlicensed**I5processorwithquadcore**
- ATXCabinet
- 512KBexternalcache
- 4GBRAM
- 500GBHDD
- COMBODRIVE–R/CD/R/W
- 48XspeedCD-ROMonEIDEcontroller
- 17”SVGALCDcolormonitor
- 8USB2serialports+1parallelport
- Internetkeyboard
- OpticalMouseandMousepad
- SecurityandManagementfeatures
- HPLaserjetPrinter(SuitableforA3sizepaper)orequivalent
- Additional software – withlicensed windows 10 OS, antivirus, antispyware Autocad latest version and firewall
- HPBusinessinkjet2800
- Allthenecessaryconsumables,includingpaper,CDs,printercartridgesetc

Thefittingsshallinclude:

(a) 2Nosof4'–0"longtubelightsineachroomexceptinConferenceroomandtoilet.
(b) 2Nos.ofnormalpendantbulbsof100wattsinallrooms
(c) 1Nos.48"ceilingfanineachroom
(d) Allroomswith2plugpointseach

These items are to be maintained in proper condition throughout the construction period and shall be removed after completion of the job, as directed by the Engineer.

No separate payment shall be made for items covered above including Engineer's office with the exception of running cost of cellular phone for which a separate provisional sum is allotted.

Assistancetothe Engineer

The Contractor shall provide all necessary assistance to the Engineer and his staff in carrying out theirdutiesofchecking,inspectingandmeasuringtheWorks.TheContractorshallprovide

chainmen, staff men, office attendants and labourers as may be needed from time to time by the Engineer at his own cost.

The Contractor shall provide for the Engineer and his staff, consultants and their staff and visitors such protective clothing, safety helmets and rubber boots of suitable sizes, hand lamps and the like as may be reasonably required by them. These articles shall remain the property of the Contractor. No separate payment shall be made on this account.

Instrumentstobeprovided

The Contractor shall provide at his own cost for the exclusive use of the staff of the Engineer all survey equipments and measuring instruments of approved make and of every kind necessary for the execution of the Works, including

One 360 degrees circle optic theodolite, to read to one second, complete with carrying case and sliding leg tripod, all to the approval of the Engineer ;Two automatic surveyor's levels with horizontal 360 degrees circle, tripod with carrying case, all to the approval of the Engineer;

Two staffs, 4.5 mlong, each in 3 sections and with attached bubbles, graduated in metres and tenth and hundredths of a meter, all to the approval of the Engineer ;

Two Surveyor's steel bands of which one shall be 100 m long and approximately 20 mm wide and one shall be at least 30 m long and approximately 12 mm wide, each fully divided, complete with tape thermometers and tension handles and wound on an open plastic cross, all to the approval ofthe Engineer ;

Anadequatenumberofrangingrods,steelandlinentapes,stringlines,pegs,lines,spirit levels, survey umbrellas, lights, batteries, stores and tools.

The instruments mentioned above shall be for exclusive use of the Engineer and shall remain inthe custody of the Engineer till the Works are completed.

TheContractorshallbesolelyresponsibleforallsuchinstrumentsandequipments andshallensure that they are at all times in good repair and adjustment, and shall make good any loss or damage howsoever caused. No separate payment shall be made on this account.

OncompletionoftheWorks,theentiresetofinstrumentsprovidedbytheContractorshall be returned back to him.

Telephone

The Contractor shall arrange for a telephone line with internet facility at each site as directed by Engineer for his sole use. The Contractor shall pay for their installation charges. A separate provisionalsumisallottedforthepaymentofcallsmadebytheEngineer.

The Contractor shall provide Two new top end Maruthi Suzuki grand vitara Hybrid version fully loaded to be kept available at all times for the sole use of the Engineer and his staff. At the end of project (after completion of Defect Liability period) the contractor shall handover the vehicle in good condition to Employer.

The Contractor shall be solely responsible for the running and upkeep for the transport including taxes, insurance, licenses, fuel, oils, lubricants, repairs and maintenance and shall also provide a competent driver with the vehicle up to the end of Defect liability period. No separate payment shall be made for providing above.

End of Part 3

PART4

GENERALREQUIREMENTS

PART4

GENERALREQUIREMENTS

Standard Specifications

Exceptwhereotherwisespecifiedtheworksunderthiscontractshallcomplywiththerequirements of the referenced Indian Standards (IS), British Standards (BS), AWWA standards, ISO standards, AWS standards, ASTM standards, etc. Other equivalent national or international Standard Specifications such as those issued by the Japanese Industrial Standards (JIS) or similar other organizations maybe consideredat the solediscretionof the Employer'sRepresentative or as may have been agreed in the contract. All standards used shall be the current version.

The Contractor shall obtain at least one copy of each IS, JIS, BS or other approved standards or reference material which are referred to in the Specification and a copy of all other standards which apply to materials which are being supplied to, or workmanship executed on the works. These standards and reference material shall be supplied to the Employer's Representative within 90 days of the Employer'sRepresentative's order to commence the works and will beavailableto the Contractor at all reasonable times.

All materials and workmanship not fully specified herein or covered by an approved standardshall be of such kind as is used in first class work and suitable to the climate in the project area.

Where the requirements of any such standard specification or regulation conflict with Employer's Requirements, then the Contractor should refer to the Employer's Representative for clarification before proceeding with that section of the works.

TenderDrawingsandContractDocuments

A list of the Tender Drawings is given in Volume 4 of this tender document. These drawings are made for tenderer's guidance only. "Released for Construction" drawings will be issued to the Contractor during the progress of work. "Released for Construction" drawings may be revised and revised copies will be issued to the Contractor during the execution of the Works. "Released for Construction"drawingswillprogressivelybeissuedduringtheconstruction,broadlyconformingto the basic scheme indicated in the tender drawings.

No claim will be entertained on the score that the details shown on "Released forConstruction" drawings are different from those shown on the tender drawings, unless the drawings indicate such items of work which are not a part of the Bill of Quantities.

The Contractor shall be furnished, free of charge, two certified true copies of the Contract Documents and all further drawings which may be issued during the progress of work as aforesaid. He shall keepone copyofthesedocumentson the Siteingood orderand the same shall at all reasonable times be available for inspection and use by the Engineer, his

representative, or other inspecting officers.

one of these documents shallbe used by the Contractor for any purpose other than thatof theContract.

Thedocumentsanddrawingsissuedasaboveremainthepropertyoftheboardands hallbe returned to the Engineer not later than the end of the Defects Liability Period.

ProgrammeofWorks

The Works to be carried out under this Contract form an important part of the construction and satisfactoryprogressoftheschemeasawholewilldependontimelycompletionofthe seworks.For this reason great importance is placed on proper programming of the civil works with adequate provisionforguardingagainstallthedelaysnormallyencounteredinconstructionw ork.Thetimefor completionofthisContractisspecifiedinAppendixtoTender(Volume3).

Noextensionoftimewill begrantedbytheEngineerinrespect ofinclement weather oritseffects (such as floods or droughts), fire or industrial disputes, unless such events could not reasonably have been foreseen by an experienced Contractor. All allowances to guard against such delays shall be clearly indicated in his programme.

Upon the award of Contract and 28 days before starting work on the site, the Contractor shall submit for the Engineer’s approval a detailed Programme of Works in the form of a PERT/CPM Networkand abarcharttogether with description of his proposed method of workingin softcopy also. The programme of the other contracts which are having interface with the present contract will be supplied to the Contractor prior to the commencement of works for proper planning and coordination with other contractors.

Progress

TheContractorshallregularlyreviewhisprogrammeinthelightoftheprogressact uallyachieved and shall submit for approval, updated PERT/CPM Network and bar charts at three months interval. If the progress fails behind that needed to ensure timely achievement of specified milestones,theContractorshallsubmitproposalsforimprovinghismethodsandp aceofworking to the satisfaction of the Engineer and shall carry out such measures which are needed to ensure that the Works are completed on time.

Meetings

From time to time the Engineer will call meetings in his office or at the Contractor's office, or at the Site, as he deems necessary, to discuss progress and any technical points requiring settlement. The Contractor's Representative or responsible representative shall attend such meetings.

The Contractor shall prepare and submit to the Engineer a daily activity report summarizing the main activities undertaken each day.

Photographs

The Contractor shall supply negatives, soft copy of photographs and unmounted positive colour printsnotlessthan250x200mmofsuchportionsoftheWorks,inprogressandcompleted,asmay be directed by the Engineer and specified herein. The negatives and prints shall not be retouched. Thenegativeofeachphotographshallbethepropertyoftheemployerandshallbedeliveredtothe Engineer with the prints. No prints of these negatives shall be supplied to any other person without the written permission of the Engineer.

Thephotographsshallbeoftwocategories:

- progressphotographs(quarterlybasis)
- recordphotographs.

Both categories of photographs shall be properly referenced to the approval of the Engineer, and on the back of each print shall be recorded the date and time of the photograph, the direction in which the camera was facing, an identifying description of the subject and the reference.

Photographs taken for record purposes as ordered by the Engineer or as specified herein shall be supplied with three prints, having the reverse of one subscribed with the signatures and seal of the Contractor and the Engineer (or their authorized representatives) for the purpose of attestation. If required, the Contractor may at his own expense have an additional print similarly attested for his retention.

TheContractorshallsupplyonenegativeandthreeprintsofeachprogressphotograph orderedbythe Engineer.The Contractor shall supplytwo additionalprints of progress photographsselected bythe Engineer for incorporation in albums. The Contractor shall supply two sets of albums, mount the prints,andtitletheprintsandalbumsalltotheapprovaloftheEngineer.Noseparatepaymentwillbe madeforthephotographsubmissionasindicatedabove.

Taking of photographs of the Works by the Contractor for any other purpose whether for use in India or in any other country shall not be carried out without written approval from the Engineer.

SiteLabourandSupervision

The Contractor shall provide all the skilled and unskilled labour required, and all necessary tools andequipmentsforexecutionoftheWorkswithintheperiodagreedintheprogramme.

The Contractor shall not remove any supervisory staff or skilled labour from the Site without the Engineer's prior approval.

Sub-letting

TheContractorshallnotsub-letthewholeoftheWorks.WhereanypartoftheWorksissublet,the Contractor shall not be relieved of his obligation under the Contract. The Contractor shall be responsible for the acts, defaults and neglect acts in the Works of any sub-contractor, as if they were his own.

Where the Engineer/Employer has consented to sub-contractors proposed by the Contractor, such manufacturers or sub-contractors shall not be changed without the prior approval in writing of the Engineer. Upon the completion of the work, the work will be acknowledged by the Engineer/Employer based on the request.

Acopyofeverysub-ordershallbesenttotheEngineer/
Employeratthetimetheorderis placed each clearly marked with the title of the

Contract and the Contract number.

Languages

Alldrawings,instructions,signs,notices,name-plates,etc.foruseintheWorksshallbeinEnglish.

Allsitesignboardsandwarningsignsshallbein KannadaandEnglish.

NoticeofOperations

The Contractor shall give full and complete written notice of all important operations to the Engineersufficientlyinadvancetoenabletheengineertomakesucharrangements astheEngineer mayconsidernecessaryforinspectionandforanyotherpurpose.TheContractorsh allnotstartany importantoperationwithoutthewrittenapprovaloftheEngineer.

ProtectionofExistingInstallations

The Contractor shall apply to the Engineer in writing at least 28 days before starting any work that involves interference with existing structures, equipment, etc. The Contractor shall not execute such work until he has received permission to proceed in writing from the Engineer. The Contractor shall ensure that no earth, debris or rock is deposited on public or private roads orrights of way as a result of the Works and all vehicles leaving the Site shall be cleanedaccordingly.

Fencing,watchingandlighting

The Contractor shall provide and maintain at his own expense all lights, guards, fencing and watching when and where necessary or as required by the Engineer for the safety and conveniences of those employed on the works or the public.

ProtectionofExistingPublicandPrivateServices

TheContractorshallnotifyallpublicauthorities,utilitycompaniesandprivateown ersofproposed worksthatwillaffectthemnotlessthantwoweeksbeforecommencingtheworks.

The Contractor shall adequately protect, uphold, maintain and prevent damage to all services and shall not interfere with their operation without the prior consent of the public authorities, utility companies, private owners or the Engineer as appropriate.

IfanydamagetoservicesresultsfromtheexecutionoftheWorks,theContractor shall immediately:

(a) NotifytheEngineerandappropriatepublicauthority,utilitycompany orprivate owner.

(b) Makearrangementsforthedamagetobemadegoodwithoutdelaytothesatis factionofthe publicauthorities,utilitycompanyorprivateownerasappropriate.TheCont ractorshallbe liableforall costsfor makinggood such damage.

The Engineer may issue instructions or make other such arrangements as he deems necessary, to repairrapidlyanyessentialservicesdamagedduringtheexecutionoftheContract.Su

charrangements shallnotaffectanyliabilitytopayformakinggoodthedamage.

Settingoutthe Works

The Engineer shall supply dimensioned drawings, levels and other information necessary to enable the Contractor to set out the Works, at his own cost, such as theodolite levelling instruments ingood working condition, all pegs, ranging rods, long measuring rods, marked meters anddecimeters and each meter and decimeter numbered, posts and sight-rails, boning rods, moulds, template etc., together with any reasonable number of labourers that may be required and set outthe Works and be responsible for the accuracy of the same. The Contractor shall amend at his own cost and to the satisfaction of the Engineer any error found at any stage which may arise through inaccurate setting out unless such error is based on incorrect data furnished in writing by the Engineer, in which case the cost of rectification shall be borne by the Board. The Contractor shall protect and preserve all control points and benchmarks used in setting out the Works till the end of the Defects Liability Period unless the Engineer directs its early removal. The Contractor should also keep the theodolite and levelling instruments in good working condition throughout the period of construction work on site.

ThecheckingofanysettingoutorofanylineorlevelbytheEngineershallnotinanywa y relieve the Contractor of his responsibility for the correctness thereof.

No separate payment will be made for setting out the Works as required. Unit rates quoted by the Contractorforallitemswillbedeemedtohavecoveredtheexpensesforsuchsetting out.

Paymentsofitemsonlumpsumbasis

Forwhichtenderpremiumare applicable.

BuildinginPlantsuppliedunderotherContracts

Plant erected under other Contractsif any, in connection with this project, which are required to be builtintostructuresconstructedunderthisContractwillbesettolineandlevel,secur edandfixedby thePlantContractorbysuchmeansaswillpermittheContractortocompletethebuil ding-inwithout disturbingthelineandlevelofftheplantsofixed.Maintainingthealignmentduringbu ilding-inwill be the responsibility of the Plant Contractor.

Openingsshallbeleftinconcretewalls,floors,roofs,etc.,asshownontheDrawings.

Plant and equipment such as pipes and valves supplied under other contracts for building-in by the Contractor shall wherever practicable, be built directly into the Works and any box-outs or holes formed for the convenience of the Contractor shall be made good properly and effectively after the inserts are placed in.

PreservationofVegetation

The Contractor shall ensure that his employees, sub-contractors (and also their employees) shall not fetch firewood from the trees around the Site. The Contractor shall be liable for any penalties levied by the concerned authorities for infringement of this regulation.

PrecautionsforworksinThoroughfares

While the execution of any work is in progress in any street or thoroughfare, the Contractor at his own cost shall have adequate provision for the passage of traffic, for securing safe access to all premisesapproachedfromsuchstreetorthoroughfare,andforanydrainage,water supply,ormeans oflightingoranyotherutilityservicewhichmaybeinterruptedtoreasonofexecution oftheWork.

Wheneveritmaybenecessarytostopthetrafficinanystreetorthoroughfare,permissionmustfirst be obtained from the Engineer and the Contractor shall then put up such barriers and adopt such othermeasuresortakeprecautionsasmaybenecessaryorastheEngineermaydirectforregulation of traffic. The work shall in such cases be executed night and day or for as long a period as practicableifsoorderedbytheEngineer,andwithsuchspeedandvigourashemayrequire,sothat thetrafficmaybeimpeded forasshortatimeas possible.TheContractorshallremove thebarriers assoonasthenecessityforthemhasceased.CareshallbetakenbytheContractortocausetheleast possible obstruction to traffic duringthe progress of thework.

LiaisioningwithRoadAuthorities&PrecautionsduringExcavation&Reinstatement

The Contractor shall liaison with road authorities (BBMP, traffic police, etc.) for all necessary permissions,works andreinstatement.Workingonthe roadwillrequiredetail planninginrelation to heavy traffic, setting out of signs and cones to direct traffic, attending leak repairs and bursts. Contractor shall prepare a scheme and shall submit for Engineer's approval. The authorities may stipulate permitted hours of work and these must be complied with. Trench excavation shall be properlyguarded and debris shall be immediatelycarried away.

Necessarytrafficsignalsandnightlightingwithdiversionsigns,conesetc.,shallbeprovided.Entire workshall be properlyplanned and executedand supervisor who is nominated forthe execution of the work must be on site at all times.

Maintenanceofundergroundutilityservices

Alltheundergroundutilityservicessuchaswaterpipes,gaspipes,drains,sewers,cableetc.,which may be met up in or about any excavation, shall if the Engineer deem it practicable, be properly maintained and protected by the Contractor himself or through other agency by means of shoring, strutting, planking over, padding or otherwise as directed by Engineer during the progress of the workwithoutclaiminganyextracharge.Anydamagetotheseundergroundutilityservicesshallbe immediately remedied by the Contractor or by the agency at his own cost, failing which the Engineermaywithorwithoutnoticeadoptsuchmeasuresashemaydeemnecessaryattheriskand cost of the Contractor.

If on the other hand, the Engineer considersimpracticable for the Contractor to maintainanysuch underground utility services and that the exigencies of the work necessitate the breaking down, removal or diversion of the said services the cost of such breaking down, removal or diversion includingthatofrebuilding,replacing,divertingandreinstatingofanysuchutilityserviceshallbe paid to the Contractor, if done by him, including the cost of provisions, pumps, chutes or other appliances as the Engineer may direct for the raising or temporary passage of the water or sewage and the cost of pumping out or removing as often as the Engineer may direct, water or sewage which may escape fromany such underground utility service.

Contractortopreservepeace

The Contractor shall at all times during the progress of the work take all requisite precaution and use his best endeavours for preventing any riotous or unlawful behavior by or amongst the workers and others employed on the Works and for the preservation of peace and protection of the inhabitants and the security of property in the neighborhood of the Works. He shall also pay the charges of such special police (if any) as the Engineer may deem necessary.

ConnectionstoExistingPipelines

ThepipelineconstructedunderthisContractshallbeconnectedtothepipelinecons tructedunderan other contract. The Contractor shall carry out all works connected with items like road surface / pavementbreaking,excavation,divertingtheroadwherenecessary,majorormino rfixtures,laying pipelines, concreting, backfilling and consolidating, restoring the road / pavement, removing diversion etc., and any other connected items required for this, though not specifically mentioned herein. The Contractor shall arrange all construction equipment, tools, tackles, cranes, diesel generatorsand/ordieseldrivenequipmentandstandbyequipmenttoensuremeeti ngthescheduled programme.TheContractorshallpreparehisprogrammeforthisworkandsubmiti tforEngineer's review and approval.

InterfacebetweenContracts

The interface between various contracts linked with this contract has been described in Part 1 of this Specifications. The Contractor shall coordinate fully with the relevant activities of the other Contractors as specified by the Engineer.

Contractor’sofficeneartheworks

The Contractor shall have an office near the Works at which notice from the Employer or the Engineer may be served, and shall between the hours of sunrise and sunset on all working days have a clerk or some other authorised person always present at such office upon whom such notices may be served and service of any notices left with such clerk or any authorised person or at such office shall be deemed good upon the Contractor.

EffectsofWeather

The Contractor shall ensure that no damage occurs to the works during construction by arranging adequateprotectionforexcavationsorbuildingworksagainsttheeffectsofdrought, sunshine,wind and rainfall (including erosion and flooding). No work shall be performed when in the opinion of the Engineer such work is liable to be injuriously affected by the weather. The Contractor shallhave no claim against the BWSSB on account of loss alleged to have been sustained directly or indirectly by reason of the Engineer declining to permit such work to start or continue or ordering any work damaged by the weather to be made good or removed and re-executed.

EndofPart 4

PART-5

TECHNICALSPECIFICATI

ONS

PART5

TECHNICALSPECIFICATIONS

A. STANDARDSPECIFICATIONS

The "*Standard Basic Specifications* " issued by the Employer, BWSSB, BWSSP(II), set out the specifications that shall be followed for construction of General Works under the BWSSP(II). Specificationsfor additional specializeditemsof civilworks,and/or for mechanical andelectrical works, are as set out in Part B, Particular Specifications, of this Section.

In the event of any discrepancy between the provisions of the Standard Specifications and the Particular Specifications, the provisions of the Particular Specifications will prevail.

B. PARTICULARSPECIFICATI

ONS CHAPTER -1

INTRODUCTION

SCOPE

Tenders scope shall broadly include but not restricted to " Providing, laying, jointing, testing and commissioning of RCC NP3 & NP4 class pipes of varying diameters" givenin tender documents. Entire work shall be carried out under overall supervision of BWSSB to their full satisfaction.

DESCRIPTIONOFWORK

Themajorworkscoveredunderthistenderaregivenbelow:

1. Earthworkexcavationfortrenchesofpipelinealongtheseweralignment.
2. Manufacture,supply,laying,jointing,testingandcommissioningofRCCNP3 class pipes **1000/1200/1800/2000mm** mm diameter
3. Constructionofpre-castandcastinsituRCCmachinehole.
4. Beddingasperdesignneeds
5. Connectingtheexistingmains/submains/laterals
6. Removeofexistingpipewhereverapplicable
7. Cement concrete encasement for sewers that are constructed in the Storm Water Drains (SWD).
8. Refillingthetrencheswithgoodqualitygravelandcartingsurplusexcavated earth from site.
9. Dismantlingofexistingstructuresandconstructionoftemporarydiversion structures
10. Fieldtestofpipeline.
11. Trenchlesstechnology
12. Roadrestorationworks
13. AnyotherworkstobecarriedwiththeapprovalofEngineer.

SPECIFICATIONDRAWINGS

Thespecificationdrawingsareincorporatedintenderdocuments.Thesedrawingsaremade for tender’s guidance only. "Released for construction" drawings will be issued to the contractor during progress of the work. "Released for" construction" drawings may be revised and revised copies may be issued to the contractor wherever necessary during execution of the work. It shall be appreciated that for work of this nature included in this contract,therearelimitationsforissuingconstruction drawings at tender stage
andhence""ReleasedforConstruction"drawingsprogressivelyissuedduri

ngconstructionbroadly

conforming to the basic scheme as shown in the tender drawings, shall form a part of the contract. No claim will be entertained on the score that details shown on "Released for Construction" drawings aredifferent fromthose shown onthetender drawings, unlessthe drawings indicate such items of work which are not a part of the Bill of Quantities.

ENVIRONMENTALIMPACT

Thecontractorshouldcomplywithstateandnationalenvironmentalst andards and guidelines.

MATERIALS

a. The term "Materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kindto be supplied by the Contractor for incorporation in the works.

b. Except as may be otherwise specified for particular parts of the Works the provision of Clausesin"materialsand workmanship" shall applyto materialsand workmanship for any part of the works.

c. All materials shall be newand of the kinds, qualities described inthe Contract and shall be at, least equal to approved samples.

d. Materialsshallbetransported,handledandstoredinsuchamannera sto prevent deterioration, damage or contamination failing which such damaged materialswillberejectedandshallnotbeusedonanypartoftheWorks under this contract.

SAMPLESANDTESTSOF MATERIALS

a. The Contractor shall submit samples of such materials including FRC machine holes covers, pre-cast concrete blocks, RCC NP3 or pipes as may be required by the Engineer and shall carry out the specified tests directed by the Engineer at the Site, at the supplier's premises or at a laboratory approved by the Engineer.

b. Samples shall be submitted, and tests carried out sufficiently early toenable further samples to be submitted and tested if required by the Engineer.

c. TheContractorshallgivetheEngineersevendays’noticeinwritingof the date on which any of the materials will be ready for testing or inspection at the supplier's premises or at a laboratory approved by the Engineer. The Engineer shall attend the test at the appointed place within seven days of the said date on whichthematerialsareexpectedtobereadyfortestingorinspection according to the Contractor, failing which the test may proceed in his absence unless instructed by the Engineer to carry out such a test on a mutually agreed upon date in his presence. The Contractor shall in any case submit to theEngineer within seven days of every test such number of certified copies (not

exceeding six) of the test readings as the Engineer may require.

d. Approval by the Engineer as to the placing of orders for materials or as tosamples or tests shall not prejudice any of the Engineer's powers under the Contract particularly as to the provisions of under the Conditions of Contract.The provisions of this clause shall also apply to materials supplied under any nominated sub-contract.

STANDARDS

a. The special attention of the Contractor is drawn to the relevant Sections and Clauses of the National Building Code of India 1984 and Karnataka State Standard Specifications & latest IS Specifications (latest editions as amended) and should follow all the specifications and conditions strictly.

b. Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current at the thirty-first day of December, 1989, unless a more recent amendment is specified hereinafter, or with the requirements of any other authoritative standard approved by the Engineer which shall be no less exacting in the opinion of the Engineer than the corresponding standard quoted herein.

c. Where the relevant standard provides for the furnishing of a certificate to the Employer,athisrequest,statingthatthematerialssuppliedcomplyinallrespects with the standard, the Contractor shall obtain the certificate and forward it to the Engineer.

d. The specifications, standards and codes listed below are made a part of this specification. All standards, tentative specifications, specifications, codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

e. If no standard is indicated, the relevant Indian Standard, if any, shall apply. Indian standards are published by:

IndianStandardsInstitution
ManakBhavan, 9, Bahadur Shah Zafar Marg NEW DELHI - 110002

f. In case of discrepancy between the Specification and the Standards referred to herein, the Specification shall govern.

i) <u>Materials</u>

Code	**Description**	**Remark**
IS:269-1989	SpecificationfororordinaryPortlandcement	
IS383-1970	Specificationforcoarseandfineaggregatesfromnatural sources for concrete.	
IS:432	Specificationformildsteelandmediumtensilesteel	
IS:650-1971	Specificationforstandardsandusedfortestingofcement(upto 40-mmdiameter)forstructuralpurposes	
IS:4111-1986	Codeofpracticeforauxiliarystructuresinsewerage system (Machinehole).Part1	
IS:1239(part-I)	CodeforSteeltubes	
IS:651- 1992	Specificationforsalt-lazedstonewarepipesandfittings	
IS:458-2003	Specificationforrecastconcretepipes(withandwithout Reinforcement).	
IS:783-1985	CodeofPracticeforLayingofconcrete pipes	
IS:5382-1985	SpecificationforRubberSealingRingsforGasMains,Water Mains and Sewers	
IS:5455-1969	SpecificationforCastIronstepsformachinehole	
IS:4127-1983	Codeofpracticeforlayingofglazedstoneware pipes.	

IS:1786	Specification for steel high strength deformed bars for concrete reinforcement.	

Code	Description	Remark
IS:4990	Specificationforplywoodforconcreteshutteringworks	
IS:12330-1988	SpecificationforSulphateResistancePortlandCement	

ii) Tests

Code	Description	Remark
IS:516-1959	Methodoftestforstrengthofconcrete.	
IS:1199-1959	Methodofsamplingandanalysisof concrete	
IS: 2386-1963 (PartsI-VIII)	Methodsoftestforaggregateforconcrete.	
IS:2720(PartsI-XLI)	Methodsoftestforsoils	
IS:3025(Parts1-59)	Methodforsamplingandtest(physicalandchemical)forwater usedin industry	

iii) Codesof Practice

Code	Description	Remark
IS:456-2000	Codeofpracticeforplainandrefined concrete	
IS:800	CodeofpracticeforuseofstructuralsteelinGeneral building construction.	
IS:919	Recommendationforlimitsandfitsforengineering	
IS:'1597(PartsI & II)	Constructionofstone Masonry	
IS:2502	Codeofpracticeforbendingandfixingofbarsforconcrete.	
IS:2571	Codeofpracticeforlayinginsitucementconcreteflooring	
IS:3558	Code of practice for use of immersion vibrator for consolidating concrete.	
IS:3935	Codeofpracticeforcomposite concrete	
IS:4014(PartsI& II)	Codeofpracticeforsteeltabular scaffolding	
IS:10005	SIunitsandrecommendationsfortheuseoftheirmultiples and ofcertainotherunits.	

CHAPTER-2

SUBMITTALS

DESCRIPTION

Thissectioncoversadditionalrequirementsforsubmittalsandformsapar tofall other sections in which submittals are required.It issubjected to General Conditionsof Contract.

Submittalrequirementstobeincluded:

1. CPMProgressSchedule
2. Samples
3. Materiallistsandequipment
4. Factorytestreports
5. Certificates
6. Laboratorytestreports

SUBMITTALREQUIREMENTS

CPMProgress Schedule

Within 30 days of award of the tender, submit a critical path method analysis for construction progress control and make such revisions as are required for approval. Clearly indicate all construction activities, sub activities and mile posts on a time oriented basis, with the critical path fully identified for all activities. Update and resubmit the charts monthly, flag all slippage's and mile posts and attach a narrative description of the proposed corrective actions to the resubmitted charts. Include the following minimum information for each activity and critical path item:

i. Dateandinitialsubmittal,asapplicable.
ii. Orderingdatesforlongleadtimeitems.
iii. Datesformaterialsonsite.
IV. Testingandcleanup.
V. Finalcompletionandhandingover.

SAMPLES

The Contractor has to submit samples of all materials used for the work prior to start the works and get the approval of the Engineer in charge. Label or tag each sample or setofsamples,identifyingthemanufacturer'snameandaddress,brandna me,catalogue number, project title and intended use.

MATERIALLISTSANDEQUIPMENTDATA

The Contractor has to submit all material lists. Equipment lists etc. well in advance before starting the work and get the approval from the Engineer in charge.

CHAPTER-3

SITEPREPARATION

BENCHMARKS

Permanentbenchmarksatleastoneineverykilometer,shallbefixedcarriedfromnearest BWSSB Bench marks before any work is started by the contractor in any section; These benchmarks shall be fixed away from the field of work so as not to be disturbed duringthe contract Period and shall be accurately fixed in concrete pillar/pedestal . No separate payment shall be paid towards fixing of bench marks. `

CLEARINGSITEOFLARGETREES,STRUCTURESETC.

This shall include the removal of large trees, stumps, structures, services such as cables, watersupply,sewerage,stormwaterdrainsetc.orpartsthereoflyingalongthealignment of sewer. The contractor should inform the Engineer in charge before removing trees, structures, other services and structures etc. well in advance. Large trees and other valuables arethe property of theGovernment and itshould be properlystacked alongthe sideoftheroadandconveyedtotheplaceasperdirectionsofthedepartmentalEngineer. The cutting of trees or demolitions of structure are done in such a way that it should not disturb the traffic and pedestrians.

REMOVALOFTOPSOIL,SHRUBSANDOTHERVEGETATION

The work has to be tackled in between two adjacent machine hole only. All shrubs, vegetation and other plants shall be removed and cleared from the selected stretch of the site. All debris and unsuitable material up to a depth of 30 cm between ground level or roadlevelshallberemoved. Alldebris andunsuitablematerial shall be cartedawayfrom the site as per the direction of departmental engineer. The payment against this item as per Bill of Quantities includes loading, unloading, carting the material to a site selected by the contractor at his own cost.

PREPARATORYWORK,SIGHT-RAILSANDBONINGSTAVES

The centre line of the trench is first marked out on the ground duly driving pegs at convenient intervals. Before commencement of earth work excavation, levels shall be taken along the centre line of the proposed sewer at intervals of say 10 m and at the machine holes locations. A longitudinal section (LS) of the profile of the ground surface showing the proposed sewer, indicating the gradients and giving the invert levels of the sewer as well as the machine hole is provided with the tender. This L.S may be updated by the contractor and approved by the Engineer before taking up the work.

The width of the trench to be excavated is marked on both sides of the centre line andexcavation lines cut out.

Two wooden posts 100 mm x 100 mm x 1800 mm high shall be firmly, erected/fixed across the centre line i.e on either side at nearly equal distance, from the centre line and sufficiently clear of all intended excavation such that the poles/posts are not disturbed during the course of execution of the work. These posts are so arranged and fixed

that a sight-rail when fixed at a level against these posts shall cross the centre line of sewer or centre of the machine holes, as the case may be.

Thesight-railmadefrom250mmwidex40mmthickwoodenplanksshallbescrewedto thepoles.Thesight-railsshallbetrulyhorizontal.Thecentrelineofthesewershallbe

markedonthesight-railbyfixinganailorotherwiseasdeterminedbytheEngineer.The sight-railsmaybefixedabout1.25mabovetheground,whichisconvenientdistancefor sighting by a leveling instrument. The sight-rails have to be so fixed that when a line sightedalongthetopedgeof the sight-railsshall represent the truefall orgradient ofthe proposedsewer.Thisgradientistransferredbelowthegroundlevelbymeansofboning- rod. Boning is carried out between the sight-rails with the help of a cord or a rope extended from nail to nail fixed on the sight-rails.

Boningrodswithcrosssection75x50mmofvariouslengthsshallbeprepared withwood. Each length shall be a certain number of meters and shall have fixed tee-head. (A cross piece of 450x 100 mm is to be fixed with nails at the top of the boning rod so as to form shape like aTee-square) and a cross piece about 300mm longfixed at the bottom of the boning staff. The distance between the top of Tee head and the cross piece shall depend upon the site requirements viz, dia of pipe, depth of cutting, level of sight-rail, designed levelofsewer,etc.Theboningrodmustbemarkedontwosidestoindicateits fulllength. Accordingtothe circumstancesofeach case,asuitable lengthofboningrod,dulyfixing the cross piece, will be determined upon the reduced level of the invert of pipe at each sight-rail.

The sight-rail and vertical posts shall be perfectlysquare and planed smooth on all sides and edges. This arrangement of erecting poles with sight-rail shall be done at suitable intervals depending on the site requirements, as directed by the Engineer. The posts and rails must in no case be removed until the trench is excavated, the pipes are laid and permission given to proceed with the filling in.

PROBINGPITS

Before starting the excavation of trenches, the contractor shall dig probing pits of size 1 m x 1 m and 1.5 m deep including road cutting at every 100 m interval along the alignment to accurately locate and determine the position of existing utilities and obstructions. The contractor shall refill the probing pits in layers of 15 cm with excavated earth up to the original ground level. In all cases the probing pits are to be excavated in accordance with the specification for excavation, refilling etc.No separate payment will be made for these probing pits.

UTILITIESPROTECTION

All utilities within the site, such as water, storm and sewage mains, shall be ascertained by probing pit results at various intervals.

All utility lines and structures, whether indicated on the drawings or not, which are to remain in service shall be protected by the contractor from any damage likely to result from his operations. Relocation wherever necessary, shall be with the approval of the Engineer and the Utility Authority. Payment will be made as per the Bill of Quantities onlyforrelocatingthe utilities. Anydamage to

anyutilityresultingfromthe contractor's operations shall be repaired at the contractor's expense.

PAVEMENTREMOVAL

ThecontractormustinformtheEngineerbeforethestartingofworkwellinadvancesothat itcanbecommunicatedtootherconcerneddepartments.The contractormustprovideand

maintain proper and efficient traffic control system such as safety lamps, sign boards etc. operatingdayandnightforthefulldurationofwork.TheBWSSBshallnotber esponsible under any circumstances for any mishappenings therefore. For the purpose of payment of removalofpavement,steeltapesaretobeusedandthemeasurementshallbe takenjointly bytheEngineer'srepresentativeandcontractororhisrepresentative.Thew idthoftrenches shall be as per table-1 and only such widths shall be taken into account for computing quantities for payment. For other elements of work such as machine hole, making cross connections, fixing other appurtenances etc. the engineer shall prescribe the dimensions for removal of pavement from time to time.

MAINTENANCEOFTRAFFICANDCLOSINGOFSTREETS

The work shall be carried out in such a manner which will cause the least interruption to traffic, and the road/street may be closed in such a manner that it causes the least interruption to traffic, Where it is necessary for traffic to cross open trenches, suitable bridges shall be provided. Suitable signs indicating that a street is closed shall be placed and necessary detour signs for the proper maintenance of traffic shall be provided.

INTERRUPTIONTOSERVICE

Novalveor othercontrol of theexisting servicesshallbeoperatedwithoutthepermission of the authority.

WORKDURINGNIGHTS

Itisexpectedthattheintensityoftrafficislikelytobelessinthenightsfrom22.00hoursto 5.00hours.Hence,forefficientuninterruptedwork,thecontractorshallequi phimselfwith the required manpower, materials, and machinery to do the work exclusively in the above periods alone. No separate payment will be made for doing the work in the nights. The contractor shall get prior approval from the Engineer-in-charge before starting the work duringnights.

CHAPTER-4

EARTHWORK

DESCRIPTION

The work specified in this section includes the provision of all labour, machinery, construction equipment and other appliances required to perform all earth work shown on the drawing or otherwise specified or required, in a sound, workmanlike manner.

GENERAL

Excavationshallberequiredtobedoneforthefollowingworks:

a) Excavationsforundergroundsewerlines
b) Excavationsforsewerlinesbelowstormwaterdrains
c) Excavationsformachinehole,footings,pedestalsetc.
d) No separate payment shall be made for removal of shrubs, grass, large and small bushes, trees, stumps and stems of trees cut, fencing including posts and gates

SOILINVESTIGATIONS

Soil analysis reports of proposed sewer alignment are available with BWSSB officials.Additional soil tests if necessary shall be carried out along the alignment and the soil boring logs shall be prepared by the contractor at his own cost. Where off-site materials have to be used, the contractor shall, if the Engineer desires make available certified soil test reports including information regarding sieve analysis, plastic limit, liquid limit, maximum density, optimum moisture content etc. from an approved testing laboratory.

CLASSIFICATION

Theexcavationworkshallbeclassifiedintothefollowingcategories:

a) Forsewerlinetrenches

i) Loamy, clayey soils like BC soils, red earth, ordinarygravels, hard gravel, mixture of gravel and soft disintegrated rock, ordinary gravel, stony earth and earth mixed with fair sized boulders, hard disintegrated rock or soft rock or conglomerate rock, to be removed by pick axes and crow bars,

ii) Hard rock and boulders to be removed only by chiseling and benching/diamond rope cutting.

b) Machinehole,pedestalsetc.

i) Loamy, clayey soils like BC soils, red earth, ordinarygravels, hard gravel, mixture of gravel and soft disintegrated rock, ordinary gravel, stony earth and earth mixed with fair sized boulders, hard disintegrated rock or soft rock or conglomerate rock, to be removed by pick axes and crow bars.

ii) Hardrockandboulderstoberemovedbybenchingandchiseling/diamondropecutting.

TRENCHEXCAVATION GENERAL

Trench excavation means excavation of trenches into which the pipe is to be laid. The line and levels of trenches shall be as shown on the drawings or as may be directed by the Engineer in charge. Before commencing trench excavation, the route of the trenches shall be pegged out accurately and the natural ground levels shall be agreed with the Engineer in charge.

WIDTHOFTRENCH

The width of trenches measured at the crown of the pipe shall permit adequate working space. The trenches shall be widened at sockets and other structures as may be found necessary. The widths to be adopted are shown in respective drawings. If the widths of actual excavation are more than the specified, it has to be made by the contractor with no separate payment. Care should be taken to avoid excessive trench widths and thereby increasing the load on the pipes.

DEPTHOFEXCAVATIONOFTRENCH

The depths for thetrencheswill be calculatedfromthesurface tothe bed of the pipes and in case when a layer of bedding is to be placed below the pipe line, the depth to the bottom of the bedding will be paid. The depth of excavation for machine hole shall be measured from the surface of the existing ground level to the bottom of foundation. No payment will be given beyond this depth.

MAXIMUMLENGTHOFOPENTRENCH

The stretch of work to be tackled shall be limited to two adjacent machine hole. However, the Engineer may permit only reasonable trench excavation in advance of the lengths between two adjacent machine hole to ensure lying and jointing of pipes can reasonably be expected to be completed and the trench refilled not attention later than 3 days after excavation of the trench. The Contractor will not be permitted to keep trenches open for unduly long periods, creating public hazards. The Engineer's decision in this respect shall be final.

TRENCHSIDES

Loose boulders shall be removed from the sides of the trenches before allowing workmen intothe excavation, and the trench sides shall be stabilized with screening or other methods approved by the Engineer. Trench slopes shall be kept moist where necessary to prevent local sliding as ordered by the Engineer.

WIDENINGTRENCHATJOINTS, ETC.

Any widening or deepening of the trench, whether in ordinary soil or rock, necessary to accommodate curves, joints or bends as shown on the drawings or ordered by the Engineer shall be carried out by the contractor.

OVER-EXCAVATIONOFTRENCHBOTTOMS

All excavation carried below the grades shown on drawings, shall be refilled with compacted bedding material at the Contractor's expense.

EXCAVATEDMATERIAL

Thematerialfromtheexcavationshallbedepositedoneithersideofthetrenchleavingclearberm on one side at least 40 cm wide or at such further distance from the edges of the trench as may be necessarytopreventtheweightofmaterialsfrom causingthesideofthetrenchtosliporfall,or at such a distance and such a manner as to avoid covering fire-hydrants, sluice valves, machine

holes covers and the like and so as to avoid any wall or structure or causing inconvenience to the public or other persons or otherwise as the engineer may direct, till it is carted away.

Theexcavatedsoilshouldbesoplacedandhandledasnottoinconveniencetheusualtraffic,tillit iscartedaway.Thecontractorshouldalsoprovidenecessarybridgingovertheexcavatedtrenches for the house-holders and pedestrians to cross over and vehicular crossings if and where required at no extra cost; if the Engineer decides that there is no hindrance to traffic due to not carting away the excavated earth, he will give instructions to that effect..

The machine holes frames and covers from the existing machine hole shall be carefully removed and stored in a suitable place away from the trenches. The contractor should not break the machine holes frames and covers while removing. The contractor is responsible for the safety of machine holes frames and covers.

PIPEBEDDING

i) GranularBedding

The bed of trenches shall be prepared as per drawing. Sand used for back fill shall be natural sand (free from cinders, ashes, slag, refuse, organic materials, boulders, rocks or stones) graded from fine to coarse. The total weight of clay in it shall not exceed 10%. All materials shall pass through a sieve of aperture size 6.30 mm.

ii) ConcreteBedding

This type of beddingis as per the drawing appendedwith the tender document, and is to be provided at locations shown in the Longitudinal Section drawings or asspecified by the Engineer. A concrete bedding using M15 is to be adopted. The concrete work related to this specification is detailed in the specifications of concrete and allied works.

In case of sewers laying in storm water channels, the pipe shall be encased with reinforced cement concrete grade as mentioned in BOQ or as directed by Engineer Incharge with a minimumthickness of 150 mmall around or as per bedding drawing. if the clear distance between bed and pipe top is less than one meter.

TRENCHEXCAVATIONINHARDROCK

If any material which in the opinion of the Contractor can be classified as rock, is encountered,he shall immediately inform the Engineer and the level, extent and description of the material encountered shall be measured jointly and recorded before excavation.

Only such proportion of material notified and measured which is certified by the Engineer as "rock", shall be paid for as rock excavation.

Excavation for trenches in rock shall be so carried out that the clearance between the pipe, when laid in position and the sides and trench bottom shall be kept to the minimum limits necessary to provide for specified thickness of bedding, and surround to the pipe as specified. Excavation outside the specified limits shall not be paid for and any additional expenses incurred inproviding additional strength to the pipe to overcome the

increased trench loads on account of increased width shall be at the Contractor's expenses. The rock thus excavated shall be auctioned as directed by Employer/Engineer and the auctioned amount shall be remitted to the Employer/Engineer

EXCAVATIONFORAPPURTENANCES

Excavation in trenches for foundation of machine hole, pedestals etc. shall be as per the plan oras directed by the Engineer. The dimensions of the excavation shall be measured as theprojection in plan of the outermost edges of the structure.

PUMPINGSEWAGEORDIVERSIONBYGRAVITYANDDEWATERING

General

TheworksincludedinthisSectionareasfollows:

1) Provision of all labour, equipment, materials etc. to ensure a safe and dewatered condition and free from sewage flow in all areas in which the work in this contract is to be executed.
2) Continuousoperationofthedewateringsystemsisrequiredtocomplete allportionsof the works where dewatering and pumping of sewage is necessary to prevent inflow, collectionofsurfacewaterorgroundwater,orsewageortoprotectadjace ntproperties or constructions from damage resulting from a rise or fall of ground water levels or sewage.
3) Removaloftheequipmentwhennolongerrequired.

PUMPINGSEWAGE

1) The existing sewer, which has to be replaced, and existing machine holes which hasto be dismantled or reconstructed, are having house connections which contribute sewage. The contractor is expected to tackle a stretch in between two adjacent machine hole. The contractor should make arrangements as detailed below for pumping the incoming sewage to enable to dismantle machine hole, approved sewers and reconstruct new machine hole and relay new sewers in the same alignment.
2) Temporary pumps are to be installed and temporary pipes provided to pump sewage from upstream machine holes selected by him to a downstream machine holes. Alternatively, it can be diverted by the gravity, if possible.
3) Temporary pumps should also be installed and temporary pipes provided to intercept the sewage flows entering the sewers and machine hole from house connections and pump out or divert by gravity, if possible into a downstream machine holes. Alternatively, the sewage coming from house connections can be diverted, if possible by gravity through pipes or channels into the nearest machine holes.
4) Suitable precast/prefabricated cisterns have to be provided to intercept incoming sewage atmachineholeandhouseconnectionsinwhichpumpscanbeinstalled.

5) This pumping arrangement and diversion arrangement has to be kept functional tillthe stretch of sewer is completed and commissioned. Stand-by pumping equipment may be kept in safe to ensure continuous pumping of the sewage so that the existing sewerage system is functional during the period of relaying the new sewer.

PUMPINGOUTWATER

The contractor shall provide and work at his own cost all pumps, engines and machineryrequisite to keep the trenches for the sewers or foundations and all other excavations clear of water, whether subsoil water, storm water, sewage, leakage from tanks, wells, drains, sewers, watermainsorpipesetc.,sothattheremaybenoaccumulationsofsuchwaterandthatno setting

out may be done, no masonry may be laid, no concrete deposited, no joints made and no measurements taken in water.

The pumping shall be continued so long after execution of any portion of the work and repeated so after as the Engineer may consider necessary. The pumps and power applied must be such as the Engineer may consider necessary for the work to set. The pumps and power applied must be such as the Engineer may determine to be sufficient to any particular time, or he may himself supply pumps and power at contractor's expense, so he may stop the work altogether until he is satisfied and also impose a fine upon the contractor.

KEEPEXCAVATIONCLEAROFWATER

Where ground water is encountered or anticipated the contractor shall provide sufficient pumpstohandletheingressofwaterandmustprovideandmaintaininworkingorder.Standbypumping units are to be made available and employed in the event of mechanical failure. The contractor must also arrange for nightand dayoperation of the pumps wherever necessaryto ensure thatthe work proceeds at all times.

BARRICADING,WATCHING,LIGHTING

Thepartsofthebarricadingshallbeoftimber,securelyfixedinthegroundnotmore than2.50m apart. Theyshall not be less than 10 cmin diameter and not less than 1.5 mabove the surface of the ground. There shall be two rails, one near the top of the posts and the other about 0.50 m above the ground and each shall be of 5 cm to 10 cm in diameter and sufficiently long to run from post to post to which they shall be tied with strong ropes. The method of projecting rails beyond the posts and tying together where they meet will not be allowed on any account. All along the edges of the excavated trenches, a bund of earth about 1 m high shall be formed when so required by the Engineer for further protection. Proper provision shall be made for lighting at night and watchmen shall be kept to see that this is properlydone and maintained. In additionto thenormallightingarrangementsthecontractorshallprovide,wheneversuchwo rkisinprogress, battery operated blinking lights (6 volts) in the beginning and end of a trench with a view to provide suitable indication to the vehicular traffic. The contractor shall also provide and display special boards printed with fluorescent prints indicating the progress of work along-the road. In theeventofthecontractorsnotcomplyingwiththeprovisionsoftheclause,theywil lbeimposed a fine at Rs.500/- per day. Further, in all such cases the work may be carried out departmentally at the risk and cost of the contractor. The contractor shall be held responsible for all claims for compensation as a result of accident or injury to person and non-provision of red flags.

Thecontractorshallathisowncostprovideallnoticeboardsbeforeopeningofroad sasdirected by the Engineer.

Arrangements shall be made by the contractors to direct traffic when work is in progress. No separate payment shall be paid for this item of work.

REFILLINGTRENCHES

1) With a view to restrict the length of open trenches, on completion of the pipe, laying operations, refilling of trenches shall be started immediately by the contractor. Pipe layingandtestingshallfollowcloselyupontheprogressoftrenchexcava tionandthe contractor shall not permit unreasonable excessive lengths of trench excavation to remain open while awaiting testing of the pipe line.

2) The trench shall be filled by borrowed gravel up to at least 30 cm. above the top of pipe, back filling is to be done keeping at least 90 cm. length of pipe open at the joints, for verification of joints for water tightness during testing.
3) Care shall be taken while back filling, not to injure or disturb the pipe. Filling shall be carried out simultaneously on both the sides of the pipes so that unequal pressure does not occur.
4) Walking or working on the completed pipeline shall not be permitted unless the trench has been filled to a height of at least 30 cm over the top of the pipe except as may be necessary for tamping, etc., during back filling work.
5) Filling-inshallbedoneinlayersnotexceeding200 mminthicknessaccompaniedby adequate watering, ramming, etc., so as to get good compaction up to 300 mmabove the top of the pipe. Above this level, useful excavated earth free from boulders shall beplacedinlayersof225mm,wateredandcompactedbytamping.Wher everpipeis laid in the storm water channel, total refilling shall be done with borrowed earth.
6) Thetrenchshallberefilledso astobuilduptotheoriginal groundlevel, keepingdue allowance for subsequent settlement likely to take place.
7) Beforeandduringthebackfillingofthetrench,precautionsshall betakenagainstthe floatation of the pipeline due to the entry of large quantities of water into the trench causing an uplift of the empty or the partly filled pipeline.
8) In case of sewers laid in storm water channels, after refilling is done, the bed of the channel to the extent trench width shall be made with cement concrete of grade M15 with a thickness of 150mm.
9) Optimum Moisture Content (OMC) test to be carried at trench section and Maximum Dry Density(MDD)testfortherefilledsoilintrenchtoconfirmtheproper compaction up to 95% of maximum dry density.

REFILLINGTHEROADSURFACE

After the backfilling is completed, the contractor shall restore the surface of the trench over the pipe to that road surface existing prior to excavation, i.e., either bitumen or cement concrete as the case may be and verified from the adjacent surface. This will be paid as per the Bill of Quantities. The width for the payment of road cutting or restructuring will be only as per the direction of the Engineer. The workof restructuringof road surface either bybitumen or cement concrete shall be as described in chapter Road restoration.

SUBSIDENCEINFILLING

Should any subsidence take place in the filling at any place of work i.e. atmachine hole andover pipe trenches and road surface whatsoever during contract, the contractor shall make good the same at his own cost or the engineer may with or without notice to the contactor make good the same in any way and with any material that he may think proper, and at the expense of the contractor. The engineer may also, if he anticipates the occurrence of any subsidence, take necessary action deemed fit in which case also the expenses therefore shall be charged to the contractor.

DISPOSALOFEXCAVATEDMATERIALS

Excavated materials shall be used for refilling etc. and surplus earth shall be disposed off to the outskirts of corporation safely with all leads and lift as directed by the engineer in charge for which no separate payment will be made.

ALLWORKSTOBECLEAR,CLEANAND PERFECT

The contractor, after completion of entire work and before seeking settlement of his final bill, shall prove at his expense that the entire line is clear, clean and perfect in the presence of the Engineer or his authorized subordinate. He should provide suitable instruments, appliances etc., and pass themthrough thepipes and shall show that water passes freely through the entire reach from higher end to lower end.

Note:Necessaryprecautionssuchasthoseindicatedhereundermaybetakenbyt he contractor while checking the completed sewer line for its effective functioning, wherever required.

The machine hole should be kept open, as required for one hour prior to the starting of checking operations and should be so kept open during the whole duration of checking operations. This is to be done for allowing the gases to escape, naturally. In order to prevent the fire andexplosions, .endangering the life, properties, sewers and other utility services due to presence of combustible gases, no lighted match sticks or other similar material should be thrown in the machine holes.

Meshes should be placed over the opened machine hole to prevent pedestrians etc., from falling in. Likewise, caution boards printed in fluorescent letters such as "DANGER MACHINE HOLES IS KEPT OPEN" etc., shall be provided.

MEASUREMENTANDPAYMENT

The payment of excavation shall be made on quantity basis as per the actual dimensions of the trench excavated limited to the width shown in the drawings.

a) Trenchexcavation

The length of the trench excavation shall be measured along the centre line of pipe at various depths stated in the Bill of Quantities, the total length being segregated into stretches accordingto the various depths of excavation contained in the Bill of Quantities to fall into the specified categories. Within each stretch the depth applicable shall be within the range specified in Bill of Quantities.

The depth of excavation shall be measured from the top of the trench at the centre before excavation upto the bottom of the bedding under the pipe. If no bedding is provided, the measurement shall be to the level of the bottom of the pipe line. The width of the trench shall be measured on the basis of vertical side walls and the specified widths. No additional paymentshall be made for the widening at sockets, specials, hunching or surrounds beyond thedimensions specified.

b) Structures

Measurement for structure excavation shall be made as per the projection in plan of theoutermost edges of the, structure as per the plan at the bottom.

c) Rockexcavation

The depth of rock excavation measured for payment shall not exceed the corresponding depth in ordinary excavation plus 150 mm both for structure. and trench excavations.

In all above cases, no payment will be made for additional selected fill, lean concrete, bedding cradlingor hunchingconcrete that maybe specified orordered bythe Engineer asa consequence of excavating beyond the limits specified in the contract documents or ordered by the Engineer.

The contractor has to auction/dispose/use himself the excavated hard rock and the revenue generated in this manner will be recovered in his payment at the prevailing rate of Royalty with applicable GST.

d) Disposalofexcavatedmaterial

All the excavated material shall be carted away and the contractor shall be paid as per the Bill of Quantities and it includes loading, unloading, transporting to a site as per Engineers directions.

If the Engineer decides that there will be no hindrance to traffic by not carting away the excavated material, he willgive direction accordingly. In such case, payment willbe restricted to only such quantities carted out.

CHAPTER5

CONCRETEANDALLIEDWORKS

GENERAL

The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise shall conform to the applicable portions of this specification.

The Engineer in-charge shall have the right to inspect the source/s of material/s, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer-in-charge’s approval obtained, prior to starting of concrete work. However, this shall not relieve the contractor with any of his responsibilities and all the materials, which do not conform to the specifications, will be rejected.

APPLICABLECODES

The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein this bid document, this specification shall govern.

Materials

IS: 269 -

Specificationfor33gradeordinaryPortlandcement IS:

455 - Specification for Portland slag cement.

IS:1489 - SpecificationforPortland-pozzolanacement.

IS:8112- Specificationfor43gradeordinaryPortlandcement.

IS:12330- SpecificationforSulphateresistingPortlandcement.

IS: 383 - Specificationforcoarseandfineaggregatesfromna tural sources for concrete.

IS: 432 - Specificationformildsteelandmediumtensilesteel(Parts-I&II)bars and hard-drawn steel wires for concrete reinforcement.

IS: 1786 - Specificationforhighstrengthdeformedsteelba rsand wires for concrete reinforcement.

IS: 1566 - Specificationforhard-drawnsteelwirefabricfor(Part-I) concrete reinforcement.

IS:9103 - Specificationforadmixturesforconcrete.

IS: 2645 - Specificationforintegralcementwaterproofingcompounds.

IS: 4990 - Specification for plywood for concrete shuttering work.

MaterialTesting

IS: 4031 - Methodsofphysicaltestsforhydraliccement. (Parts-1to13) IS: 4032 - Method of chemical analysis of hydraulic cement.

IS: 650 - Specificationforstandardsandfortestingofcement. IS: 2430 - Methods for sampling of aggregates for concrete.

IS:2386- Methodsoftestforaggregatesforconcrete.(Parts-ItoVIII)

IS: 3025 - Methods of sampling and test (physical and chemical) water used in industry.

IS:6925 - Methodsoftestfordeterminationofwater-soluble chloridesin concrete admixtures.

MaterialsStorage

IS: 4082 - Recommendationsonstackingandstoringofconstructionmaterials at site.

ConcreteMixDesign

IS: 10262 -

Recommendedguidelinesforconcretemixdesign. SP: 23 - Handbook on Concrete Mixes. (S & T)

ConcreteTesting

IS: 1199 -

Methodofsamplingandanalysisofconcrete. IS: 516 - Method of test for strength of concrete.

IS: 9013 - Method of making, curing and determining compressive strengthofacceleratedcuredconcretetest specimens.

IS: 8142 - Methodoftestfordeterminingsettingtimeofconcreteby penetration resistance.

IS: 9284 - Methodoftestforabrasionresistanceofconcrete. IS: 2770 - Methods of testing bond in reinforced concrete.

Equipment

IS:1791 - Specificationforbatchtypeconcretemixers. IS:2438 - Specification for roller pan mixer.

IS:4925 - Specificationforconcretebatchingandmixingplant. IS:5892 - Specification for concrete transit mixer.

IS:7242 - Specificationforconcretespreaders.

IS:2505 - GeneralRequirementsforconcretevibrators:Immersiontype. IS:2506 - General Requirements for screed board concrete vibrators.

IS:2514 - Specification for concrete vibrating tables. IS:4656 - Specificationforformvibratorsforconcrete.

IS:11993 - Codeofpracticeforuseofscreedboardconcretevibrators. IS:7251 - Specification for concrete finishers.

IS:2722 - Specification for portable swing weigh batchers for concrete (single

anddoublebuckettype).

IS:2750 - Specificationforsteelscaffoldings.

Codesof Practice

IS:456 - Codeofpracticeforplainandreinforcedconcrete.

IS:457 - Codeofpracticeforgeneralconstructionofplainand reinforced

concretefordamsandothermassivestructures.

IS:3370 -

Codeofpracticeforconcretestructuresforstorageofliqui ds.(Parts-I toIV)

IS:3935 - Codeofpracticeforcompositeconstruction.

IS:2204 - Codeofpracticeforconstructionofreinforcedconcreteshellroof.

IS:2210 - Criteria for the design of reinforced concrete shell structures and folded plates.

IS:2502 - Codeofpracticeforbendingandfixingofbarsforconcretereinforcement.

IS:5525 - Recommendation for detailing of reinforcement in reinforced concrete works.

IS:2751 - Code of practice for weldingof mild steel plainand deformed bars

IS:9417 - used forreinforcedconcreteconstruction.

IS:3558 - Specificationforweldingcoldworkedbarsforreinforced concrete construction.

concrete. Codeofpracticeforuseofimmersionvibratorsforconsolidating

IS:3414 Code of practice for design and installation of joints

in building. IS:4326 -Code of practice for earthquake resistant

constructionof building. IS:4014 - Code of practice for steel

tubular scaffolding. (Parts-I & II)

IS:2571 - Codeofpracticeforlayingin-situcementconcrete flooring.

IS:7861 - Codeofpracticeforextremeweatherconcreting. Part-I:Recommendedpracticeforhotweatherconcreting. Part-II : Recommended practice for cold weather concreting.

IS:13920 -

DuctileDetailingofReinforcedConcreteStructuresubjectedtoseismic forces.

SP-16 -

DesignAidsforReinforcementConcretetoIS:456- 1978 (S&T)-1980

SP-24 - ExplanatoryHandbookonIS:456-1978

SP-34 -

HandbookonConcreteReinforcementandDetailing

(S&T) – 1987

ConstructionSafety

IS:3696 - Safety code for scaffolds and ladders. (Parts-I

& II) IS:7969 -

Safetycodeforhandlingandstorageofbuildingmaterials

IS:8989 - Safety code for erection of concrete framed structures.

Measurement

IS:1200- Methodofmeasurementofbuildingandengineeringworks(PartI-28).

IS:3385- Codeofpracticeformeasurementofcivilengineeringworks..

MATERIALSFORSTANDARDCONCRETE

The ingredients to be used in the manufacture of concrete shall consist solely of Ordinary PortlandCement,andSulphateresistantcementcleansand,naturalcoarseaggregate,clean water, and admixtures, if specifically called for on conditions at site warrant its use. Only river sand shall be used for all works.

Cement

Thecontractorwillhavetomakeownarrangementsforprocuringcementandsteel.

The Contractor will have to make his own arrangements for transport from supplier godown and storage of adequate quantity of cement. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from the ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will notbe permitted to be used and shall be removed from the site. The storage bins and storage arrangement shall be approved by the Engineer-in-charge. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery.

Cement held in storage for a period of ninety (90) days or longer shall be tested. Should at anytimetheEngineer-in-chargehavereasonstoconsiderthatanycementisdefective,then irrespective of its origin, date of manufacture and or manufacturer's test certificate, such cement shall be tested immediately at the Contractor's cost at an approved laboratory and untiltheresultsofsuchtestsarefoundsatisfactory,itshallnotbeusedinanywork.Testing certificatesforeachbatchofcementshouldbesubmittedbythecontractortotheEngineerin charge,beforestartingtheconcretingwork.TheContractorshallnotbeentitledtoanyclaim of any nature on this account.

Aggregate

General

"Aggregate" in general designates both fine and coarse inert materials used in the manufacture of concrete (Vide BIS 456 & BIS 383) and confirming to tests as per BIS: 2386 (Part I to VI)

"Coarse Aggregate" is aggregate most of which is retained when passed through on 4.75 mm BIS sieve.

All fine and coarse aggregates proposed for use in the works shall be subject to the Engineer-in-charge's approval and after specific materials have been accepted, the source ofsupplyofsuchmaterialsshallnotbechangedwithoutpriorapprovaloftheEngineer-in- charge.

Aggregates shall consist of natural sands, stone (crushed or uncrushed) and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, non-flaky, strong, hard, durable against weathering, of limited porosity and free from

deleterious materials that may cause corrosion of the reinforcement or may impair the strength and or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the “mix design” and preliminary tests on concrete specified later. Aggregate source shall be approved by BWWSSB.

SamplingandTesting

Samples of the aggregates for mixed design and determination of suitability shall be taken under the supervision of the Engineer in-charge and delivered to the laboratory, well in advance of the scheduled placing of concrete. Records of tests, which have been made on proposed aggregates and on concrete made from this source of aggregates, shall be furnished to Engineer in-charge in advance of the work, for use in determining aggregate suitability. The costs of all such tests, sampling etc. shall be borne by the contractor.

StorageofAggregates

Allcoarseandfineaggregatesshallbestackedseparatelyinstockpilesinthe materialyard nearthe worksiteinbinsproperlyconstructedtoavoidintermixingofdifferen taggregates. Contamination with foreign material and earth during storage and while heaping the materialsshallbeavoided.Theaggregatesmustbeof specifiedqualitynotonlyatthetime of receiving at site but more so at the time of loading into mixer. Rakers shall be piled in layers not exceeding 1.20 m in

height to prevent coning or segregation. Each layer shall cover the entire area of stockpile before succeeding layers are started. Aggregates that have become segregated shall be rejected.

Specific Gravity

Aggregateshavingaspecificgravitybelow2.4(saturatedsurfacedrybasis)shallnotbe used.

Fine Aggregate

a. Fine aggregate shall consist of natural or crushed sand conforming to BIS 383 confirming to tests as per BIS 2386 setting qualities/strength/durability of concrete.

b. Screening and Washing: Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separatingthe sandgrains tothe required size fraction.

c. **Foreign Material limitations: The** percentage deleterious substances in sand delivered to the mixer shall not exceed the following:

Table1:ForeignMaterialLimitationsinFineAggregate

S.No.	**ForeignMaterial**	**Percentagebyweight**	
		Uncrushed	**Crushed**
1	Materialfinerthan75micro n BIS	3.0	15.0
2	Shale	1.0	-
3	Coal& Lignite	1.0	1.0
4	Claylumps	-	1.0
Total		5.0	17.0

d. **Gradation: Unless** otherwise directed or approved by the Engineer-in-charge, the grading of sand shall be within the limits indicated hereunder:

Table2:GradingofSandforFineAggregate

BIS: Sieve	GradingZone	GradingZone	GradingZone	GradingZone

Designation	I	II	III	IV
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-90	90-100
600µm	15-34	35-59	60-79	80-100

Where the grading falls outside the limits of any particular grading zone of sieves, other than600 microns ISsieve,bytotal amountnotexceeding5%, itshallberegardedas falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron IS sieve or to percentage passing any other sieve on the coarser limit of grading zone Ior the finerlimit ofgradingzone IV. Fine aggregates conformingto gradingzone IV shall be used.

Mix designs and preliminary tests shall show its suitability for producing concrete of specified strength and workability.

Fineness Modulus: The sand shall have a fineness modulus of not less than 2.2 or more than 4.2. The fineness modulus is determined by adding the cumulative percentages retained on the following IS sieve sizes (4.75 mm, 2.36 mm, 1.18 mm, 600 microns and 150 microns) and dividing the sum by 100.

CoarseAggregate

Coarse aggregate for concrete, except as noted above, shall conform to IS 383 & IS 2386. This shall consist of crushed stone and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

Screening and Washing: Crushed rock shall be screened and or washed for the removal of dirt or dust coating, if so requested by the Engineer in-Charge.

Grading

i) Coarseaggregateshall beeitherinsinglesizeor graded,inbothcasesthegrading shall be within the following limits:

BIS: Sieve Size	Percentagepassingforsinglesizedaggregateof normal size					Percentagepassing for graded aggregateofnormalsize			
	40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
63 mm	100	-	-	-	-	-	-	-	-
40 mm	85-100	100	-	-	-	95-100	100	-	-
20 mm	0-20	85-100	100	-	-	30-70	95-100	100	100
16 mm	-	-	85-100	100	-	-	-	90-100	-
12.5 mm	-	-	-	85-100	100	-	-	-	90-100
10 mm	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75 mm	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36	-	-	-	-	0-5	-	-	-	-

mm									

ii) The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale, if present, shall be only within tolerance limits which will not affect adversely the strength and or durability ofconcrete. The maximum size of coarse aggregate shall be 40 mm for M-7.5 and M-10 and 20mm for M-15 to M-20 concrete, or as directed by the Engineer-in-charge or specified otherwise. The maximum size of coarse aggregate shall be the maximum size specified above but in no case greater than 1/4th of the minimum thickness of the member,providedthattheconcretecanbeplacedwithoutdifficultysoasto surroundall reinforcement thoroughly and fill the corners of the form. For plain concrete the maximum size of aggregate shall be of 40 mm. For heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5 mm less than the minimum clear distance between the reinforcing main bars or 5 mm less than the minimum cover to reinforcement whichever is smaller.

BI S Siev e Size (m	Percentagepassingforsinglesized aggregateofnormalsize					PercentagePassingForGraded AggregateOfNormalSize			
	40	2016 mm		12.5 mm	10	40mm	20mm	16mm	12.5 mm
63	100	-	-	-	-	100	-	-	-
40	85-100	100	100	-	-	95-100	100	-	-
20	0-20	0-5	0-20	0-45	0-100	30-70	95-100	100	90-100
16	0-5	-	0-5	-	85-100	10-35	25-55	30-70	40-85
4.75	0-5	0-5	0-5	0-10	0-20	0-5	0-10	0-10	10-40
2.36	-	-	-	-	85-100	-	-	-	90-100

Foreignmateriallimitations

The percentage of deleterious materials in the aggregate delivered to the mixer shall not exceed the following:

Table3:ForeignMaterialLimitationsinCoarseAggregate

S.No.	**ForeignMaterial**	**Percentagebyweight**	
		Uncrushed	**Crushed**
1	Materialfinerthan75micron BIS Sieve	3.0	3.0
2	CoalandLignite	1.0	1.0
3	ClayLumps	1.0	1.0
4	SoftFragments	3.0	-
Total		8.0	5.0

Water

a. Water used for washing, mixing and curing shall be free from injurious amounts of deleterious materials. Potable water is generally satisfactory for mixing and curing concrete. Physical and chemical analysis of the water should be submitted to the Engineer-in-charge, before starting the work.
b. In case of doubt, the suitability of water for making concrete shall be ascertained by thecompressivestrengthandinitialsettingtimetestspecifiedinIS456. Thesampleof watertakenfortestingshallbetypicalofthewaterproposedtobeusedfor concreting, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.
c. Average 28 days compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. The cubesshall be prepared, cured and tested in accordance with the requirements of BIS: 516.
d. The initial setting time of test block must be made with the appropriate test cement and the water proposed to be used. It shall not be less than 30 minutes and shall not differ by more than + 30 minutes from the initial setting time of control test block prepared with the appropriate test cement and distilled water. The test block shall be prepared and tested in accordance with the requirements of BIS: 4031.
e. Where water can be shown to contain an excess of acid, alkali, sugar or salt, Engineer-in-charge may refuse to permit its use. As a guide, the following concentrations represent the maximum permissible values.
    1. To neutralise 200 ml sample of water, using phenolphthalein as indicator, it should not require more than 2 ml of 0.1 normal NaOH. The details of test shall be as given in BIS: 3025.
    2. To neutralise 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 Normal HCl. The details of test shall be as given in BIS: 3025.
    3. Percentageof solids,whentestedinaccordancewiththemethodindicatedbelow shall not exceed the following:

CONTROLLEDCONCRETE

All concrete in the works shall be “Controlled Concrete” as defined in IS: 456 except for M-7.5 and M-10 for which normal mix concrete shall be used. Whether reinforced or otherwise,allconcreteworkstobecarriedoutunderthisspecificationshallbe divided into the following classifications:

Note: It shall be veryclearlyunderstood that whenever the grade of concretesuchas M-20, etc. is specified it shall be contractor’s responsibility to ensure the minimum crushing strength stipulated for the respective grade of concrete is obtained at works. Minimum cement content intheconcreteusedforliquid/waterretainingstrengthshallbe390 kg/cu.m for 20 mm downgraded aggregate.

Class	PreliminaryTestN/mm^2		WorksTest N/mm^2		Maximum size of aggregate mm	Locations for use
	At7Days	At28Days	At7Days	At 28 Days		
M40	33.5	50.0	27.0	40.0	20	Asindicated in the specifications orasrequired

M30	25.0	38.0	20.0	30.0	40or20	-do-
M25	22.0	32.0	17.0	25.0	40or20	-do-
M15	13.5	20.0	10.0	15.0	40or20	-do-

MIXDESIGN

General

This is essential for investigating the grading of aggregates, water-cement ratio, workability and the quality of cement required to give preliminary and works cubes of the minimum strength specified. The proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made. Determination of mix proportions shall be carried out according to “Recommended guidelines for Concrete Mix Design” conforming to IS: 10262.

Whenever there is a change either in required strength of concrete, or water-cement ratioor workability or the source of aggregates and/or cement, preliminary tests shall be repeated to determine the revised proportions of the mix to suit the altered conditions. While designing proportions, over-wet mixes shall always be avoided.

While fixing the value for water/cement ratio for preliminary mixes, assistance may be derived from the graph (Appendix A, BIS 456 showing the relationship between the 28day compressive strengths of concrete mixes with different water/cement ratios and the 7- day compressive strength of cement tested in accordance with IS: 269.

Preliminarytests

Test specimens shall be prepared with at-least two different water/cement ratios for each class of concrete, consistent with work ability required for the nature of the work. The materialsandproportionsusedinmakingpreliminarytestsshallbesimilarin allrespectsto those to be actually

employed in the works as the object of these tests is to determine the properties of cement, aggregates and water necessary to produce concrete of required consistency and to givethe specified strength, it will be contractor’s sole responsibility to carry out these tests and he shall therefore furnish to Engineer-in-Charge a statement of proportions proposed to be used for the various concrete mixes. For preliminary tests, the following procedure shallbe followed.

Materials shall be brought to the room temperature and all materials shall be in a dry condition. The quantities of water cement and aggregates for each batch shall be determined by weight to an accuracy of 1 part in 100 parts.

Mixing concrete shall be done by hand (for small quantities, as directed by Engineer-in- Charge) or in a small batch mixer as per IS: 516 in such a manner as to avoid loss ofwater. The cement and fine aggregate shall first be mixed dry until the mixture is uniform in color. The coarse aggregate shall then be added, mixed and water added and the whole batch mixed thoroughly for a period of not less than two minutes until the resulting concrete is uniform in appearance. Each batch of concrete shall be such a size as to leave about 10% excess concrete, after moulding the desired number of test specimens.

The consistency of each batch of concrete shall be measured immediately after mixing, by the slump test in accordance with IS: 1199. If in the slump test, care is taken to ensurethat nowaterorothermaterialislost,thematerialusedfortheslumptestmaybere-mixed

with the remainder of the concrete for making the specimen test cubes. The period of re- mixing shall be as short as possible yet sufficient to produce a homogeneous mass.

The samples for compression tests of concrete shall be made as per IS: 516 on 15 cm cubes.Eachmouldshall beprovidedwithametal baseplatehavingaplatesurfacesoasto support the mould during filling without leakage. The base plate shall be preferably attached to the mould by springs or screws. The parts of the mould when assembled shall be positively and rigidly held together. Before placing concrete, the mould and base plate shall be cleaned and oiled. The dimensions and internal faces of the mould shall be accurate within the followinglimits. Height and distance between the opposite faces of the mould shall be of specified size +0.2 mm. The angle between the adjacent internal faces and between internal faces and top and bottom faces of mould shall be 90-degree +0.5 degree. The interior faces of the mould shall be plane surfaces with a permissiblevariation of 0.03 mm.

Concrete test cubes shall be moulded by placing fresh concrete in the mould and compacted as specified in IS 516.

Curing shall be as specified in IS 516. The cubes shall be kept in moist air of at least 90% relative humidity at a temperature of 27°C + 2°C for 24 hours +2 hours from the time of addingwater to the dryingredients. Thereafter theyshall beremoved fromthe mouldsand kept immersed in clean, fresh water and kept at 27°C +2 degree C temperature until required for test. Curing water shall be renewed every seven days. A record of maximum and minimum temperatures at the place of storage of the cubes shall be maintained during the period they remain in storage.

The strength shall be determined based on not less than five cube test specimens for each age and each water cement ratio. All these laboratory test results shall be tabulated and furnished to the Engineer-in-charge. The test results shall be accepted by the Engineer-in- charge if the average compressive strengths of the specimens tested is not less than the compressive strength specified for the age at which specimens are tested subject to the condition that only one out of the five consecutive tests may give a value less than the specified strength for that age. The Engineer-in-charge may direct the contractor to repeat the tests if the results are not satisfactory and also make such changes, as he considers necessary to meet the requirements specified. All these preliminary tests shall beconducted by the contractor at his own cost in an approved laboratory.

PROPORTIONING,CONSISTENCY,BATCHINGANDMIXINGOFCONCRETE

The determination of the water cement ratio and proportion of aggregates to obtain the required strength shall be made from preliminary tests by designing the concrete mix. Controlled concrete shall be used on all concrete work complying with all therequirements of IS: 456. Cube tests shall be carried out bythe contractor on the trial mixes before the actual concreting operation starts. Based on the strength of the concrete mix sanction for the use has to be obtained from engineer in charge.

If during the execution of the works it is found necessary to revise the mix because of the cube tests showinglower strengthsthanthe requiredone due to inconsistencyofqualityof material or otherwise,The Engineer in charge shall ask for fresh trial mixes to be made by the contractor. No claimto alter the rates of concrete workshall be entertained dueto such change in mix variations, as it is the contractor’s responsibility to produce the concrete of the required grade.

Great care shall be exercised when mixing theactual works concrete usingtheproportions oftheselectedtrialmix.Thefinalconcretemixshallhavethesameproportion sofcement, fine and coarse aggregates and water as that of the approved selected mix.

Areasonablenumberofbagsshouldbeweighedseparatelytocheck theNetweight,where the weight of cement is determined by accepting the manufacturer's weight per bag at the site. Proper control of mixing water is deemed to be of paramount importance. If mixers with automatic addition of water are used, water should be either measured by volume in calibratedbuckets,tinsorweighed.Allmeasuringequipmentshallbemaintainedinaclean serviceable condition and their accuracy periodically checked and certified and the Engineer-in-Charge's approval obtained.

The Engineer-in-Charge may require the contractor to carry out moisture content tests in both fine and coarse aggregates. The amount of the added water shall then be adjusted to compensate for any observed variations in the moisture contents. BIS: 2386 shall be referred to for determination of moisture content.

No substitution in material, used on the work or alteration in the established proportions shall be made without additional tests to show that the quality and strength of concrete are satisfactory. No alterations shall be permitted without the prior sanction of the Engineer- in-Charge.

MIXINGOFCONCRETE

The mixing of concrete shall be strictly carried out in an approved type of mechanical Concrete mixer. The mixing equipment shall be capable of combining the aggregates. Cement and water within the specified time into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation. The entire batch shall be discharged before recharging. Mixing periods shall be measured from the time when all of the solid materials are in the mixing drum, provided that all of the mixing water shall be introduced before one fourth of the mixing time has elapsed. The mixing time in no case shall be less than two minutes. The mixer speed shall not be less than 14 nor more than 20 revolutions per minute.

Mixing shall be continued until there is a uniform distribution of the materials and themass is uniform in color and consistency. Hand mixing of concrete shall not be permitted at all.

GRADEOFCONCRETE

The different grades of concrete specified shall conformto the strengths as required by IS: 456-1987.Standard deviation shall be calculated as stated in 14.5 of IS: 456-1978. The acceptable criteria for concrete shall be as stated in clause 15 of IS: 456 -1978.The assumed standarddeviations asgiven intable6 of IS: 456-1978 hasto be followed andare given here under. However, the minimum cement content shall be as per "*Table 4: Grade of Concrete*" in this tender document.

Table4:GradeofConcrete

GradeofConcrete	AssumedStandardDeviationN/sq.mm
M10	2.3
M15	3.5
M20	4.6

In order to get a quick idea of quality of concrete the optional tests are conducted as stipulated in 14.1.1 of IS: 456-1978 and the results are analyzed according to table 5 on page 41 of IS: 4561978.

ControlledConcrete

Controlled concrete shall be used on all concreting works except where specifiedotherwise the mix proportions for all grades of concrete shall be designed to obtain strengths corresponding to the values specified in "*Table 5: Compressive Strengths at 28 days*" below for respective grades of concrete.

Table5:CompressiveStrengthsat28days

Grade	**Specified Characteristic Compressive Strength (Works strength) at 28 days**
M 10	10
M 15	15
M 20	20

The maximum Water: Cement ratio for all controlled concrete works shall be as specified in IS: 456-1978 as Preliminary tests as specified in the BIS code and required by the Engineer-in-Charge shall be carried out sufficiently ahead of the actual commencement of theworkwithdifferentgrades ofconcretemadefromrepresentativesamplesofaggregates and cement expected to be used on the job to ascertain the ratios by weight of cement of total quantity of fine and coarse aggregates and the water cement ratio required to produce a concrete of specified strength and desired workability.

The minimum cement content for each grade of concrete shall be as per "*Table 6: Minimum Cement Content in Concrete*" below:

Table6:MinimumCementContentinConcrete

GradeofConcrete	**MinimumCementContentinConcrete**
M10	220kgs
M15	240kgs
M20	330kgs
M25	360kgs
M30	360kgs

At least 4 (four) trial batches are to be made and 7 test cubes should be taken for each batch noting the slump on each mix. These cubes shall then be properly cured and two cubes for each mix shall be tested in a testing laboratory approved by the Engineer-in- Charge at 7 days and others at 28 days for obtaining the ultimate compressive strength.The test reports shall be submitted to the Engineer in charge. The cost of mix design and testingshall bebornebythecontractor.Onthebasisofthepreliminarytest reportsfortrial mix, a proportion of mix by weight and water cement ratio will be approved by the Engineer in charge, which will be expected to give the required strength. Consistency and workability and the proportions so decided for different grades of concrete shall beadheredtoduringallconcretingoperations.IfhoweveratanytimetheEngineer-in-Charge feels that the quality of material, being used has been changed from those used for preliminary mix design, the contractor shall have to run similar trial mixes to ascertain the mix proportions and consistency.

The mix once approved must not be varied without prior approval of the Engineer-in- Charge. However should the contractor anticipate any change in the quality of future supply of materials than that used for preliminary mix design, he shall inform the same to the Engineer in charge and bring fresh samples sufficiently ahead to carry out fresh trial
mixes.Theengineerinchargeshallhaveaccesstoallplacesandlaboratorywheredesign

mix is prepared. Design mix will indicate by means of graphs and curves etc. theextent of variation in the grading of aggregates which can be allowed.

In designing the mix proportions of concrete, the quantity of both cement and aggregate shall be determined by weight. All measuring equipment shall be maintained in clean and serviceable condition and their accuracy periodically checked.

To keep the water cement ratio to the designed value, allowance shall be made for the moisture contents in both fine and course aggregates and determination of the same shall be made as frequently as directed by the Engineer-in-Charge. The determination of moisture contents shall be according to IS: 2386 (Part III).

StrengthRequirements

Where ordinary Portland cement conforming to IS: 269 or Portland blast furnace slag cement conforming to IS: 455 are used the compressive strength requirements for various grades of concrete shall be as shown in table below. Where rapid hardening Portland cement is used the 28 days compressive strength requirements specified in Table- hereunder shall be met in 7 days. The strength requirements specified in table shall applyto both controlled concrete and ordinary concrete

Table7:StrengthRequirementsofConcrete

GradeofConcrete as per IS: 456-1978	**MinimumCompressiveStrengthinAccordancewithIS:516 (Inkg/cm)**			
	For15cmcubespecimen at7 days		**For15cmcubespecimenat28 days**	
M15	100	135	150	200
M20	135	175	200	260
M25	170	220	250	320

Other requirements of concrete strength as may be desired by the Engineer in charge shall be in accordance with Indian Standard IS: 456 (latest revision). The acceptance ofstrength of concrete shall be as per clause 5.4 “Sample size and Acceptance Criteria” of IS: 456 (latest revision) subject to stipulation and/or modifications stated elsewhere in this specification if any.

Concreteworkfoundunsuitableforacceptanceshallhavetobedismantledandreplacedto the satisfaction of the Engineer-in–Charge by the contractor free of cost of the owner. No payment will be made for the dismantled concrete, the relevant Formwork and reinforcement, embedded mixtures etc. wasted in the dismantled portion shall be made. In the course of dismantling if any damage is done to the embedded items or adjacent structures, the same shall also be made good free of charge by the contractor to the satisfaction of the Engineer in charge. If the water quantity has to be increased in special cases, cement also is increased proportionately to keep the ratio of water to cement sameas adopted in trial mix design for each grade of

concrete.

Workability

The workability of concrete shall be checked at frequent intervals by slump test. Where facilities exist and if required by the Engineer-in-Charge, alternatively the compacting factor test in accordance with IS: 1199 shall be carried out. The degree of workability necessarytoallowtheconcretetobewellconsolidatedandtobeworkedintoth ecorners

of form work and round the reinforcement to give the required surface finish shall depend on the type and nature of the structure and shall be based on experience and tests

Workmanship

All workmanship shall be according to the latest relevant standards. Before starting a pour the contractor shall obtain the approval of the Engineer-in-Charge in a “Pour Card” maintained for this purpose. He shall obtain complete instructions about the material and proportion to be used, slump, workability of water per unit of cement, number of testcubes to be taken, finishing to be done and any admixture to be added etc.

SAMPLINGANDTESTINGCONCRETEINTHEFIELD

a) Facilities required for sampling materials and concrete including whether proof buildings to house the facilities in the field, should be provided by the contractor at no extra cost. The following equipment with operator shall be made available in serviceable conditions.

i. Concretecube-testingmachinesuitablefor15cmcubesof100tonnes capacity with proving calibration ring - 1 no.
ii. Castironcubemoulds15cmsize-6nos.(min)
iii. Slumpconecompletewithtampingrod-1set
iv. Laboratorybalancetoweighupto5kgwithsensitivityof10gm-1no.
v. BISsievesforcoarseandfineaggregates-1set
vi. Setofmeasuresfrom5litresto0.1litre-1set
vii. Electricovenwiththermostatupto120ºC-1no.
viii. Flakinessgauge-1no.
ix. Elongationindexgauge-1no.
x. Sedimentationpipette-1no.
xi. Calibratedglassjar1.0litrecapacity-2nos.
xii. Glassflasksandmetalcontainers -As required
xiii. Chemicalreagentslikesodium hydroxide,tannicacid,litmuspaperetc.-As required
xiv. Laboratorybalanceof2kgcapacityandsensitivityof1gm-1no.

b) No concrete of any kind may be placed until the field concrete testing laboratory as specified is provided to the satisfaction of the Engineer. The contractor shall notify the Engineer in advance of all concrete and concrete material testing as provided in the clause to provide the Engineer/his representative with an opportunity to witness all prescribed tests.

c) Atleast6 test cubes of each class of concreteshallbe made of every50cumconcrete or part thereof or from different batches as directed by Engineer-in-charge. Such samples shall be drawn on each day for each type of concrete. Of each set of 6 cubes, three shall be testedat 7 days age and three at 28 days age. The cubes must be casted from various batches to arrive at an average strength. Thelaboratorytest results shall be tabulated and furnished to the Engineer. The Engineer will pass the concrete if average strength of the specimens tested is not less than the strength specified, subject to the condition that only one out of three consecutive tests may give a value less than the specified strength but this shall notbe less than 90% of the specified strength.

d) Consistency: Slump tests shall be carried out as often as requested by the Engineer and invariably from the same batch of concrete from

which the test cubes are made. Slump tests shall be done immediately after sampling.

CONCRETETESTS

The Engineer-in-Charge, may order tests to be carried out on cement, sand, coarse aggregate, and water in accordance with the relevant Indian standards.

TestsonCementshallinclude:

- Finenesstest
- Testfornormal consistency
- Testforsetting time
- Testfor soundness
- Testfortensilestrength
- Testforcompressivestrength
- Testforheatofhydration(byexperimentandbycalculations)in accordance with BIS 269

TestsonSandshallinclude:

- Sievetest
- Testfororganicimpurities
- Decantationtestfordeterminingclayandsiltcontent
- Specificgravitytest
- Testforunitweightandbulkagefactor
- Testforsieveanalysisandfinenessmodulus

TestsonCoarseAggregateshallinclude:

- Sieveanalysis
- Specificgravityandunitweightofdry,looseandroddedaggregate
- Soundnessandalkaliaggregatereactivity
- Petrographyexamination
- Deleteriousmaterialsandorganicimpurities
- Testforaggregatecrushingvalue

Any or all these tests would normally be ordered to be carried out only if the Engineerfeels the materials are not obtained and shall be performed by the contractor at anapproved test laboratory The contractor shall bear the charges of these optional tests.

Concrete not made to the requirements of specification in all respects may be rejected by the Engineer-in-Charge in which case it shall be removed and reconstructed entirely at the expense of the contractor.

LoadtestonMembersoranyothertests

i. In the event of any work being suspected of material or workmanship or both, the Engineer-in-charge requiring its removal and reconstruction may order, or the contractor may request that it should be load tested in accordance with the following provisions.
ii. The test load shall be 125% of the maximum superimposed load for which the structure was designed. Such test load shall not be applied before 56 days after the effective hardening of concrete. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members. The test load shall be maintained for 24 hours before removal.
iii. If within 24 hours of the removal of the load, the structure does not show a recovery of at least 75% of the maximum deflection shown during the 24 hours under load, the test loading shall be repeated after a lapse of at least 72 hours. The structure shall beconsidered to have failed to pass the test if the recovery after the second test is not at least 75% of the maximum deflection shown during the second test. If the structure is certified as failed by the Engineer-in-Charge, the cost of all the new construction and the load tests shall be borne by the

contractor.

iv. Any other tests, e.g. taking out in an approved manner concrete cores, examination and tests on such cores removed from such parts of the structure as directed by the Engineer- in-charge, sonictestingetc.shallbecarried out bythecontractor, if so directed, atno extra cost.

Unsatisfactorytests

Shouldtheresultsofanytestproveunsatisfactory,orthestructureshowssignsofweakness, unduedeflectionorfaultyconstruction,thecontractorshallremoveandrebuildthemember or members involved or carry out such other remedial measures as may be required by the Engineer-in-Charge.

ADMIXTURES

General

Admixtures may be used in concrete where required, only with the approval of the Engineer-in-Charge. How ever it should be seen that, with the passage of time, neither the compressive strength nor its durability is reduced. Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embeddedsteelparts.Whencalciumchlorideispermittedtobeused,suchasinmassconcreteworks, it shall be dissolved in water and added to the mixing water in an amount not to exceed 1.5%oftheweightofthecementineachbatchofconcrete.Whenadmixturesareused,the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturer's instruction and in the manner and with the control specified by the Engineer-in-Charge.

AirEntrainingAgents

Neutralized vinson resin or other approved air in the concrete mix agents shall conform to the requirements of ASTM standard 6.260; Air Entraining Admixtures for Concrete. The recommended total air content of the concrete is 4% + 1%. The method of measuring air content shall be as per IS: 1199.

WaterReducingAdmixtures

Waterreducinglignosulfonateadmixturemaybeaddedinquantitiesapprovedbythe Engineer-in-charge. The admixtures shall be added in the form of a solution.

RetardingAdmixtures

Retardingagentsmaybeaddedtotheconcretemixinquantitiesapprovedbythe Engineer-in-Charge.

WaterProofingAgent

WaterproofingagentsshallconformtoIS:2645.

OtherAdmixtures

TheEngineer-in-

Chargemayathisdiscretionallowthecontractortouseanyotheradmixture in the concrete.

PREPARATIONPRIORTO CONCRETEPLACEMENT,FINALINSPECTIONAND APPROVAL

a. Before the concrete is actually placed in position, the insides of the Formwork shall be inspected to see that they have been cleaned and oiled. Temporary openings shall beprovidedtofacilitateinspection,especiallyat bottomsof columnsandwall forms, to permit removal of sawdust, wood shavings, binding wire, dirt etc. Openings shall be placed or holes drilled so that these materials and water can be removed easily. Such openings/holes shall be suitably plugged later.
b. The various agencies shall be permitted ample time to install drainage and plumbing lines, floor and trench drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedment to be cast in the concrete as specified or required or as is necessary for the proper execution of the work as specified in the drawings.
c. All embedded parts, inserts, etc. supplied by the PHED or the contractor shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.
d. All anchor bolts shall be positioned and kept in place with the help of properly manufactured templates unless specifically waived in writing by the Engineer-in- charge.
e. Slots, openings, holes, pockets etc. shall be provided in the concrete work in the position specified in drawing or required or as directed by the Engineer-in-charge.
f. Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.
g. Prior to concrete placement, all work shall be inspected and approved by the Engineer-in-Charge and if found unsatisfactory, concrete shall not be poured until after all defects have been corrected.
h. Approval by the Engineer-in-Charge of any and all materials and work as required herein shall not relieve the contractor from his obligation to produce finished concrete in accordance with the requirements of the specifications.
i. Rainorwashwater:Noconcreteshallbeplacedinwetweatheroronawater-covered surface.Anyconcretethathasbeenwashedbyheavyrainsshallbeentirelyremoved, if there is any sign of cement and sand having been washed away from the concrete mixture. To guardagainst damage, which may be caused byrains, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work unattended. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no furtherconcreteshallbeplacedthereonuntilsuchwaterisremoved.Toavoidflowof water over/around freshly placed concrete, suitable drains and sumps shall be provided. During summer season, temperature of water should be maintained, as per the criteria and for the same, icing should be done for concreting work.
j. Bonding Mortar: Immediately before concrete placement begins, prepared surfaces except Formwork, which will come in contact with the concrete to be placed, shallbe covered with a bonding mortar as specified.
k. The corrosive matters on the reinforcement should be removed by means of wire brush.
l. Laitance should be removed by means of chiseling from top concrete layer which was earlier concreted.

TRANSPORTATION

General

All buckets, containers or conveyors used for transporting concrete shall be mortar-tight, leakproof irrespective ofthe method oftransportationadopted;concrete shall bedelivered with the required consistency and plasticity without segregation or loss of slump.However, chutes shall not be used for transport of concrete without the written permission of the Engineer-in-charge and concrete shall not be re-handled before placing.

RetemperedorContaminatedConcrete

Concrete must be placed in its final position before it becomes too stiff to work. On no account, water shall be added after the initial mixing. Concrete, which has become stiff or has beencontaminated withforeign materialsshallberejectedanddisposed offasdirected by the Engineer-in-Charge.

AvoidingSegregation

Concrete shall, in all cases, be deposited as nearly as practicable directly, in its final position and shall not bere-handled to flowina manner which will causesegregation,loss of materials, displacement of reinforcement, shuttering or embedded insets, or impair its strength. For locations where direct placement is not possible, and in narrow forms, the Contractor shall provide suitable drop and “Elephant Trunks” to confine the movement of concrete. Special care shall be taken when concrete is dropped from a height, especially if reinforcement is in the way, particularly in column and the walls.

PlacingbyManualLabour

Except when otherwise approved by the Engineer-in-Charge, concrete shall be placed in the shuttering by shovels or other approved implements, and shall not be dropped from a height more than 1.0 m or handled in a manner, which will cause segregation.

PlacingbyMechanicalEquipment

The following specification shall apply when placing concrete by use of mechanical equipment is warranted considering the nature of work involved. The control of placing shall begin at the mixer discharge. Concrete shall be discharged by a vertical drop into the middle of the bucket or hopper and this principle of a vertical discharge of concrete shall be adhered to throughout all stages of delivery until the concrete comes to rest in its final position.

TypesofBuckets

Central-bottom-dump buckets of a type that provides for positive regulation of the amount and rate of deposition of concrete in all dumping positions, shall be employed. In placing concrete in large open areas, the bucket shall be spotted directly over the position designatedandthenloweredfordumping.Theopenbucketshallclearthecon cretealready in place and the height of drop shall not exceed 1.0 m. The bucket shall be opened slowly to avoid high vertical bounce. Dumping of buckets on the swing or in any manner, which results in separation of ingredients or disturbance of previously placed concrete, will notbe permitted.

PlacementofRestrictedForms

Concrete placed in restricted forms by barrows, buggles, cars, short chutes or hand shoveling shall be subject to the requirement for vertical delivery of limited height toavoid segregation and shall be deposited as nearly as practicable in its final position.

Chuting

Where it is necessary to use transfer chutes, specific approval of Engineer-in-charge must be obtained to type, length slopes, baffles, vertical terminals and timing of operations. These shall be so arranged

that an almost continuous flow of concrete be obtained at the discharge and without segregation. Concrete should flow smoothly in the chute and there should not be any obstruction to the flow. To allow for the loss of mortar against the sides of the chutes, the first mixes shall have less coarse aggregate. During cleaning of chutes, thewastewatershallbekeptclearoftheforms.Concreteshallnotbepermitte dtofall

from the end of the chutes by more than 1.0 m. Chutes, when approved for use shall have slopes not flatter than 1 vertical, 3 horizontal and not steeper than 1 vertical, 2 horizontal. Chutes shall be of metal or metal lines end of rounded cross section. The slopes of allchute sections shall be approximately the same. The slopes of all chute sections shall be approximately the same. The discharge end of the chutes shall be maintained above the surface of the concrete in the forms.

PlacingbyPumping/PneumaticPlacers

Concretemaybeconveyedandplacedbymechanicallyoperatedequipmente.g.,pumpsor pneumatic placers only with the written permission of the Engineer-in-Charge at no extra cost. The slump shall be held to the minimum necessary for conveying concrete by this method.

When pumping is adopted, before pumping of concrete is started, the pipeline shall be lubricated with one or two batches of mortar composed of one part cement and two parts sand. Care shall be taken to avoid stoppages in work once pumping has started.

When a pneumatic placer is used, the manufacturer'sadvice on layout of the pipeline shall be followed to avoid blockages and excessive wear. Restraint shall be provided at the discharge box to cater for the reaction at this end. Manufacturer's recommendations shall be followed regarding concrete quality and all other related matters when pumping/ pneumatic placingequipment is used. It should be noted that no extra payment is made for these items, if required and directed by Engineer-in-Charge.

Concreteinlayers

Concreting,oncestarted,shallbecontinuousuntilthepouriscompleted.Concreteshallbe placed in successive horizontal layers of uniform thickness ranging from 15 cm to 45 cm directedbyEngineer-in-Charge. Theseshall be placedas rapidlypracticable toprevent the formation of cold joints or planes of weakness between each succeeding layer within the pour. The thickness of each layer shall be such that it can be deposited before the previous layerhasstiffened.Thebucketloadsorotherunitsofdepositshallbespottedprogressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth and texture with a minimum shoveling. Any tendency to segregation shall be corrected by shoveling stones into mortar rather than mortar on to stones. Such a condition shall be corrected by redesign of mix or other means, as directed by the Engineer-in-charge.

CoverBlocks

Coverblocksofrequiredsizedependingon thecoverofthereinforcementasmentioned in the drawingsshouldbepreparedin1:3cementmortarwithfineaggregates.

Beddingof layers

Thetopsurfaceofeachpourandbeddingplanesshallbeapproximatelyhorizontalunless otherwiseinstructed.Toplayershouldberoughandwithkeyforfurtherextensionofwork.

Compaction

Concrete shall be compacted during placing with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, as specified in the IS, isfreeofpocketsofcoarseaggregateandfitstightlyagainstallformsurfaces,

reinforcement and embedded fixtures. Particular care shall be taken to ensure that all concrete placed against theformfacesand intocornersof forms against hardenedconcrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution exercised not to over vibrate the concrete to the point those segregation results.

Typeofvibrators

Vibrators shall conform to BIS specifications. Type of vibrator to be used shall depend on the structures where concrete is to be placed. Shutter vibrators to be effective, shall be firmly secured to the formwork which must be sufficiently rigid to transmit the vibration and strong enough not to be damaged by it. Immersion vibrators in sufficient numbers and each of adequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted.

UseofVibrators

The exact manner of application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention be paid to vibration at the top of a lift e.g. in a column or wall.

MeldingSuccessiveBatches

When placingconcretein layers, which are advancinghorizontallyas the workprogresses, great care shall be exercised to ensure adequate vibration blending and melding of the concrete between the succeeding layers.

PenetrationofVibrators

The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

VibratingagainstReinforcement

Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after startof initial set. They shall also not be allowed to come in contact with forms or finished surfaces.

Use ofFormAttachedVibrators

Form attached vibrators shall be used only with specific authorization of the Engineer-in- Charge.

Useofsurfacevibrators

The use of surface vibrators will not be permitted under normal conditions. However, for thin slabs, surface vibrating by specially designed vibrators may be permitted, upon approval of Engineer-in-charge.

The formation of stone pockets and mortar pondages in corners and against faces of forms shall not be permitted. Incase of these occur, theyshould be dugout, reformed and refilled to sufficient depth and shape for thorough bonding, as directed by the Engineer-in-charge.

PlacementInterval

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for atleast 24 hours after the final set of concrete and before thestart of a subsequent placement.

SpecialProvisioninPlacing

When placing concrete in walls with openings, in floors of integral slabs and beam construction and other similar conditions, the placing shall stop when the concrete reaches the top of the opening in walls or bottom horizontal surface of the slab, as the case may be.Placing shall be resumed before the concrete in place takes initial set, but notuntil ithas had time to settle as determined by the Engineer-in-Charge.

PlacingConcreteThroughReinforcingSteel

Whenplacingconcretethroughreinforcingsteel,careshallbetakentopreve ntsegregation of the coarse aggregate. Where the congestion of steel makes placing difficult, it may be necessary to obtain Engineer in-Charge's permission for temporarily moving the top steel aside for proper placement & for restoring reinforcement as per drawing.

Bleeding

Bleedingorfreewateron topofconcretebeingdepositedintotheforms,shallbethecause to stop the concrete pour and the conditions causing this defect corrected before anyfurther Concreting is resumed.

APPLICATIONOFARALDITEFORBONDINGOFNEWANDOLDCONCRETE

General

Araldite epoxy resins will be used to bond fresh concrete to concrete that is fully cured, to give a monolithic bond capable of transmitting high stresses when traditional bonding agentssuchascementslurrycannotalwaysbereliedupontoprovide goodadhesionwhich is particularly the case when large areas are involved.

a. The Araldite based formulation shall be applied to suitably prepared concrete sub- strata and the fresh concrete poured as soon as possible, but always during the 'open time' of the adhesive.
b. Materialsusedshallbeofbestqualityandapprovedbytheengineer-in-charge.
c. Manufacturer'sinstructionsshallbefollowedinallrespects.
d. Noseparatepaymentshallbepaidforthisitemofwork.

Formulation

AralditeGY250	100	Partsby weight
HardenerHY825	20	Partsby weight
HardenerHY830	20	Partsby weight

HardenerHY850	20	Partsby weight
SilicaFlour	20	Partsby weight

Application

PreparationoftheSubstrata

Toobtaingoodadhesion,itisnecessarytohavecleanandsoundsubstrata.Preparationcan be carried out using a variety of techniques including chemical treatment and mechanical methods such as grinding, milling, abrading, planing and sand blasting. Dust and loose particles resulting from the pretreatment should be removed by vacuum cleaning or oil-free or blast.

Mixing

The resin and hardener should be thoroughly mixed in the dry filler. The mixed, ready to use adhesive should not contain lumps of unwetted filler and should be of uniform color. For atotal weight of 1kgor lesshand mixingshouldbe sufficient. For quantitiesin excess of 1 kg, the use of a mechanical mixer is recommended

Potlifeand'Opentime'

The pot life is the period during which the ready to use ARALDITE based formulation must be applied. After this period, the mix can no longer be worked and will have begunto set in its container. The table below indicates the pot life at different temperatures:
(Thefiguresinthistableareforbatcheslessthan1kilogram).
The 'Open time' is the maximum period of time allowable between application of the ARALDITE adhesive and pouring the fresh concrete. Exceeding the 'Open time' would result in considerably reduced adhesion. The adhesive should be applied to the pre-treated substrata as soon as the components have been mixed and fresh concrete poured immediately afterwards.
Accurateknowledgeofthe'Opentime'isessentialincasetheworkisinterrupted.

Table gives the 'Open time' of ARALDITE based formulations as a function of substrata temperature. In all cases, the adhesives shall be applied immediately after mixing. Any delaybetween mixingand application will reducethe'Open time'. Fresh concrete must be poured before the adhesive begins to gel. New to old concrete bonding is notrecommended at temperatures below 5°C, as curing cannot be assured under these circumstances.

MethodsofApplication

Theshapeandsizeoftheconcretestructurewilldeterminethemethodofapplicationused. The ARALDITE based adhesive may be applied by hand using brushed, brooms or any other suitable applicator.

SuitabilityofFreshConcrete

Best results are obtained when the water/ cement ratio of the new concrete is low as is practicable.

MixTemperature(DegreeCelsius)	**PotLife(minutes)**
25	90
30	60

Coverage

One kilogram of the mixed ARALDITE adhesive including hardeners and filler covers an areaof2 to 3sq.m. when applied witha stiffnylon bristle brush.However, the coverage is very much dependent on the finish in the concrete.

HANDLINGPRECAUTIONS

Epoxy resins can cause irritation of the skin in sensitive person if incorrectly handled. Certain safety precautions must therefore be observed and those handling the resins and hardeners should be given suitable instructions. Those working with epoxy resins should, aboveall,beinstructedthatpersonal cleanlinessat theplaceof workisessential.Theresin and hardener should not be allowed to come into direct contact with the skin. The most effectiveprotectionisachievedbywearingrubberorpolythenegloves,thelatterhavingthe advantage that they can be replaced when dirty. They are more pleasant to wear if cotton glovesarewornunderneath.Partsoftheskins,whichhavecomeintocontact withtheresin or hardener, should be washed with lukewarm water and a mild soap. Special cleaning creams maybe used as they have proved to be highlysuitable.

CONSTRUCTIONJOINTS

a. A construction joint is defined as a joint in the concrete introduced for convenience in construction at which special measures are taken toachieve subsequent continuity without provision for further relative movement.
b. No concretingshall be started until theEngineer-in-Charge has approvedthemethod of placing the positions and form of the construction joints and lifts. Theconstruction jointsshallbe solocatedasnottoimpairthestrengthofthestructure. Waterstopsshallbeinsertedasperclause5.18
c. Concrete placed to form the face of a construction joint shall have all Laitance removed and the aggregate exposed prior to the placing of fresh concrete. The Laitance shall wherever practicable be removed by spraying the concrete where it is still green. The whole of the concrete surface forming part of the joint shall be hackedtoexposetheaggregate.Whereaggregateisdamagedduringhacking,it shall be removed from the concrete face by further hacking. All loose matter shall be removed and the exposed surface thoroughly cleaned by wire brushing, air blastingorwashing,leavingthesurfacecleananddamp.Immediatelybeforefreshconcreteis placed, a 12 mmthick layer of sand/cement mortar mixed in the same proportions as in the concreteshall be spread inthehorizontal face of theconstructionjoint. Adrier mix shall be used for the top lift of horizontal face of the construction joint. A drier mix shall be used for the top lift of horizontal pours to avoid Laitance. The new concrete shall be well worked against the prepared face before the mortar sets. Special care shall be taken to obtain thorough compaction and to avoid segregationof the concrete along the joint plane.

MOVEMENTJOINTS

1. Movement joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision being made where necessary for maintaining the water tightness of the joint. The contractor shall comply with the instructions of manufacturers of proprietary jointing materials and

shall, if required by the Engineer-in-Charge, demonstrate that the jointing materials can be applied satisfactorily.

2. The surface of set concrete in a movement joint shall, as shown on the drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry. Expansion joints shall be formed by a separating stripof approved preformed joint filler.
3. Caulking grooves shall be provided. At all joints where a caulking groove is formed, immediately prior to caulking, thegroove shall be wire brushed and loosematerial

removed and blown out by compressed air. After the groove has dried, it shall be primedandcaulkedwithapprovedsealingcompoundappliedinaccordanceiwiththe manufacturer'sinstructions.At all caulked joints,thefaceof thecaulkingstripanda width of concrete on either side shall be painted with two coats of paint having the same base as the sealing compound.

WATERSTOPSANDJOINTFILLERS

Waterstops

a. At all construction, contraction and expansion joints in the water retaining structures and wherever specified or directed by the Engineer-in-Charge, water stops shall be provided. Thewaterstops shallbePVCtype or ofanyotherequivalent materialasapproved bythe Engineer-in-Charge. PVC water stops shall have a tensile strength of not less than 14 MN/sq.m and elongation at break of not less than 300%. Water stops shall not beexposed to direct sunlight for long periods. Before being concreted in water stops shallbe cleaned of all foreign materials. Wherever provided, water stops shall be placed in such a manner that they are embedded in the adjacent sections of the panels for equal width.
b. As far as possible, jointing on site shall be confined to the making of butt joints in straight runs of water stops and all the joints should be monolithic. Where it is agreed with the Engineer-in-charge that it is necessary to make an intersection or change of direction of any joint, other than a butt joint in a straight run on site, a preliminary joint, intersection or change of direction piece shall be made and submitted to such tests as the Engineer-in-charge may require.
c. Flexible water stops shall be fully supported in the formwork, free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place the concrete so that water stops do not bend or distort.
d. Thedifferenttypesofwaterstopstobeusedinliquidretainingstructureswillbeasper"
*e. Table*9:TypesofWaterStops".
a. Table9:TypesofWaterStops

Sr. TypeofJoint Typeofwaterstops

1. Partial/complete contractionjointinwallsandslabs
2. Expansion joints in walls and slabs

S.No.	TypeofJoint	Typeofwaterstops
1	Construction joint in raft	230mmwide,ribbedwithhollowcentrebulb&6mm minimum thickness
2	Construction joint in wall	230mmwide,ribbedwithhollowcentrebulb&6mm minimum thickness
3	Expansionjoint raft	230mmwide,ribbedwithhollowcentrebulb&6mm minimum thickness

Jointingfillers

Jointfillersshallbeofdurable,compressibleandnon-extrudingmaterial.

SEALINGCOMPOUNDS

Horizontaljointsshall,whereusedinwater-retainingstructuresbesealedwithacold pouringpolysulphiderubbersealingcompoundofqualityequalto,orbetterthanserviced

"Paraseal". Horizontal joints in roofs, floors and other non-water retaining structures shall be sealed with an approved sealant with properties equal to or better than serviced "Paraplastic 41". Vertical joints and joints in the soffits of slabs in both water retaining as well as non-water retaining structures shall be sealed with a trowel or gun applied polysulphide rubber sealing compound such as serviced "Vertiseal" or equivalent. Sealing compounds shall be fully cured before water is permitted to come in contact. At 40 C, the curing time would be approximately 7 weeks for polysulphide compound.

TOLERANCESINCONCRETESURFACES

- Concrete surfaces for the various classes of unformed and formed finishes specified in variousclausesshallcomplywith thetolerancesshown inTable hereunder,except where different tolerances are expressly required by the specification.
- In the table 'line and level' and 'dimension' shall mean the lines, levels and cross- sectional dimensions as specified and required.
- Surfaceirregularities shallbeclassifiedas'abrupt' or'gradual'.Abrupt irregularities include by shall not be limited to offsets and fins caused by displaced or misplaced formwork, loose knots and other defects in formwork materials, and shall be tested by direct measurement. Gradual irregularities shall be tested by means of a straight template for plane surfaces and 1.5 m long formed surfaces.

ClassofFinish	**Maximumtolerance(mm)in:**			
	Line& level	**Abrupt**	**Gradual irregularity**	**Dimension**
U1	12	6	6	-
U2	6	3	3	-
U3	6	3	3	-
F1	12	6	6	+12-6
F2	6	6	6	+12-6

CURING,PROTECTING,REPAIRINGANDFINISHING

Curing

All concrete shall be cured by keeping it continuously damp for the period of timerequired for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays, or ponded water, continuously saturated coverings ofsacking, canvas, hessain or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, eventextured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

CuringwithWater

Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete, following a lapse of 12 to 14 hours after laying of concrete. Thecuringofhorizontal surfacesexposedtothedryingwinds shallhowever begin assoon as the concrete has hardened. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

ContinuousSpraying

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessaryappliancesofhose,sprinklersandsprayingdevices.Continuousfi nemist

spraying or sprinkling shall be used, unless otherwise specified or approved by the Engineer-in-charge.

AlternateCuringMethods

Whenever in the judgment of the Engineer-in-charge, it is necessary to omit thecontinuous spray method, a covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. No type of covering will be approved which would stain or damage the concrete during or after the curingperiod. Coveringshall be kept continuouslywet duringcuringperiod. For curingof concrete in sidewalks, floors, flat roofs of other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Engineer-in-charge. Special attention shall be given to edges and corners of the slabs to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

CuringCompound

Surface coating type-curing compounds shall be used only by special permission of Engineer-in-Charge. Curing compounds shall be liquid type white pigmented, conforming toUSBureauofReclamationspecification.Nocuringcompoundshallbeused onsurfaces where future blending with concrete, water of acid proof membrane or painting isspecified.

CuringEquipment

All equipment and materials required for curing shall be on hand and ready for use before concrete is placed.

ProtectingFreshConcrete

Fresh concrete shall be protected from defacements and damage due to construction operations by leaving forms in place for an ample period. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps as approved by the Engineer-in-Charge shall also be taken to protect immature concrete from damagebydebris,excessivelading,vibration,abrasionorcontactwithother materials,etc. that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that the workmen enter the area of freshly placed concrete, the Engineer-in- Charge may require that bridges be placed over the area.

RepairandReplacementofUnsatisfactoryConcrete

General

Immediatelyafter the shutteringis removed, the surface of concrete shall be verycarefully gone over and all defective areas called to the attention of the Engineer-in-charge whomay permit patching of the defective areas or also reject the concrete unit either partiallyor initsentirety. Rejectedconcrete shall be removed and replaced bythe contractor. Holes shall be filled with mortar composed of one part of cement to one and half parts of sand passing 2.36 mm IS sieve after removing any loose stones adhering to the concrete. Concrete surfaces shall be finished as described in specifications or as directed by the

Engineer-in-charge. Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of the Engineer-in-chargeandsuperficialwaterandairholesshallbefilledin.Themortarshallbe well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructedotherwiseby the Engineer-in-charge,the surfaceoftheexposedconcreteplaced

against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities, care being taken to avoid damaging the surface. Surface irregularities shall be removed by grinding. If reinforcement is exposed or the honeycombing occurs at vulnerable positions e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of the Engineer-in-charge shall be final in this regard. If only patching is necessary, the edges being cut perpendicular to the affected surface or with a small under cut if possible. Anchors, tees or dovetail slots shall be provided whenever necessary to attach the new concretesecurelyinplace.Anareaextendingseveralcentimetersbeyondthe edges andthe surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

UseofEpoxy

The use of epoxy for bonding fresh concrete used for repairs will be permitted uponwritten approval of the Engineer-in-charge. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

MethodofRepair

Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows.

The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops. A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patchingconcrete which shall be well consolidated with a wooden float and left slightly protrude of the surrounding surface. The concrete patch shall be built up in 10 mm thick layers, after an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. A steel trowel shall be used for this purpose. The mix for patching shall be of the same materials and in the same proportion as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible. Mortar filling by air pressure (gunniting) shall be used for repair of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by the Engineer-in-charge, to match the shade of the patch with the original concrete.

CuringofPatchedWork

The patched area shall be covered immediately with an approved non-staining, water- saturated material such as gunny bags which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray, or sprinkling for not less than 10 days. All fillings shall be tightly bounded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

ApprovalbytheEngineer-in-Charge

All materials, procedures and operations used in the repair work shall be subject to the approval of the Engineer-in-Charge.

Finishing

General

The type of finish for formed concrete surfaces shall be as follows, unless varied by the Engineer-

in-Charge.

Whenthestructureisinserviceallthesurfacesshallreceivenospecialfinish,exceptrepair ofdamagedordefectiveconcrete,removaloffineandabruptirregularities,fillingdefective concrete,fillingofholesleftbyformtiesandrodsandcleanupoflooseoradheringdebris. Surfaceswhichwillbeexposedtotheweatherandwhichwouldnormallybelevel,shallbe slopedfordrainage.Unlessahorizontalsurfaceorthesloperequiredisspecified,thetopsof narrow surfaces such as stair treads, walls, curbs and parapets shall be sloped across the width approximately 1 in 30. Broader surfaces such as walkways, and platforms shall be sloped about 1 in 50. Surfaces that will be covered by backfill or concrete, subfloors to be coveredwithconcretetopping,terrazzoorquarrytilesandsimilarsurfacesshallbesmooth ascendedandleveledtoproduceevensurfaces.Surfaceirregularitiesshallnotexceed6mm. Surfaces which will not be covered by backfill, concrete or tile toppings such as outside decks, floors of galleries and sumps, parapets, gutters, side-walks, floors and slabs, shallbe consolidated, screened and floated. Excess water and laitance shall be removed before final finishing. Floating may be done with hand or power tools and started as soon as the screened surface has attained a stiffness to permit finishing operations and these shall be the minimum required to produce a surface uniform in texture and free from screened marks or other imperfections. Joints and edges shall be tooled as specified or as directedby the Engineer-in-Charge.

StandardFinishForExposedConcrete

Exposed concrete shall mean any concrete, other than floors or slabs, exposed to viewupon completion of the works. Unless otherwise specified, the standard finish for exposed concrete shall be a smooth finish. A smooth finish shall be obtained with theuse of lined or plywood forms having smooth and even surfaces and edges. Panels of forms shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal offorms thejoint marks shallbesmoothedoff and allblemishes,protections etc.,removed leaving the surfaces smooth.

Integralcementconcretefinish

When specified, an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified or directed by theEngineer-in-charge. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surfacewaterhas evaporated. Drycementora mixtureof drycement andsandshallnotbe sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

Rubbedfinish

A rubbed finish shall be provided only on exposed concrete surfaces. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, offsets leveled and voids and/or damaged sections immediately saturated with water andrepaired by filling with a concrete or mortar of the same composition as was used in the surface. The surfaces shall then be thoroughly wetted and rubbed with carborundun or otherabrasive.Cement mortarmaybeusedintherubbing,butthefinishedsurfacesshall

not bebrushcoatedwitheither cement or grout after rubbing.Thefinishedsurfacesshall present a uniform and smooth appearance.

Protection

All concrete shall be protected against damage until final acceptance by the Engineer-in- Charge.

HOTWEATHERREQUIREMENT

a. All concrete work performed in hot weather shall be in accordance with IS: 456, except as herein modified.
b. AdmixturesmaybeusedonlywhenapprovedbytheEngineer-in-Charge.
c. Adequate provisions shall be made to lower concrete temperatures by cool ingredients, eliminating excessive mixing, preventing exposure of mixers and conveyors to direct sunlight and the use of reflective paint on mixers, etc. The temperature of the freshly placed concrete shall not be permitted to exceed 38 degrees centigrade.
d. Consideration shall be given to shading aggregate stockpiles from direct rays of the sunandsprayingstockpileswithwater,useofcoldwaterwhenavailable, andburying, insulating, shading and/or painting white the pipelines and water storage tanks and conveyance.
e. In order to reduce loss of mixing water, the aggregate, wooden forms, subgrade, adjacent concrete and other moisture absorbing surfaces shall be well wetted prior to concreting, placement and finishing shall be done as quickly as possible.
f. Extra precautions shall be taken for the protection and curing of concrete. Consideration shall be given to continuous water curing and protection against high temperatures and drying hot winds for a period of at least 7 days immediately after concrete has set and after which normal curing procedures may be resumed.

PLACINGCONCRETEUNDERWATER

a. Under all ordinary conditions, all foundations shall be completely dewatered and concrete placed in the dry. However, when concrete placement under water is necessary, all work shall conform to IS: 456 and the procedure shall be as follows:

- **Method of Placement**: Concrete shall be deposited underwater by means of tremises, or drop bottom buckets of approved type.
- **Direction, Inspection and Approval**: All work requiring placement of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. All underwater concrete shall be placed accordingto specifications approved by the Engineer-in-Charge.

b. Specialprecautionsshallbetakenforpreventionofliftingofconcreted uetouplift pressureof subsoil water.

PRECASTCONCRETE

General

Precast concrete units, whether manufactured on or off site, shall comply in every way with the provisions of the contract for in situ concrete. Wherever possible, precast units shall be hydraulically pressed. When ready for incorporation in the works, precast units shall

be responsible for the accuracy of the level, shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

StrikingForms

Side shutters shall not be struck in less than 24 hours after depositing concrete and no precast unit shall be lifted until the concrete reaches strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.

PrecastUnits

Theliftingandremovalofprecastunitsshallbeundertakenwithoutcausingshock,vibration or undue bending stresses to or in the units. Before lifting and removal takes place, contractor shall satisfy the Engineer-in-charge or his representative that the methods he proposes toadoptfor theseoperations will not over-stress or otherwise effect seriously the strength of the precast units. The reinforced side of the units shall be distinctly marked.

Curing

All precast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each unit shall be kept constantly watered or preferably be completely immersed in water if the size of the unit so permits.

SLOTS,OPENINGS, ETC.

General

Slots, openings or holes, pockets, etc., shall be provided in the concrete work in the approved positions or as directed by Engineer-in-charge. Short pipes with puddle collar shallbefixedinthesidewallofsuctionpipes.Theyshallbesuppliedattheappropriatetime during construction. Anydeviation from the approved drawings shall be made good by contractor at own expense, without damaging any other work. Sleeves, bolts, inserts etc., shall also be provided in concrete work where so required.

Grouting

StandardGrout

The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. The grout proportions shall be limited as per "*Table 10: Proportions for Standard Grout*".

Table10:ProportionsforStandardGrout

S.No.	Use	Grout Thickness	Mix Proportions	W/CRatio(max)
1	Fluid	Under 25mm	OnepartPortland cement	0.44
2	General	25 mm & over but less than 50 mm	One part Portland cement to 2 parts of sand	0.53
3	Stiff Mix	50mm&over	OnepartPortland cement to 3 parts of sand	0.53

Sand shall be such as to produce a flowable grout without

anytendencyto segregate. Sand for general grouting purposes, shall be graded within the following limits:

□	Passing BIS	2.36mmsieve	95 to 100%
□	Passing BIS	1.18mmsieve	65 to 95%
□	Passing BIS	300micronsieve	10 to 30%
□	Passing BIS	150micronsieve	3 to 10%

Sand for fluid grouts, shallhave the fine material passingthe 300 and 150 micron sieves at the upper limits specified above. Sand, for still grouts, shall meet the usual grading specifications for concrete laitance. Anchor bolts, anchor bolt holes and the bottoms of equipmentandcolumnbaseplatesshallbecleanedofalloil,grease,dirtandlo osematerial. The use of hot, strongcaustic solution for this purposewill be permitted. Prior to grouting, thehardenedconcretesurfacestobegroutedshallbesaturatedwithwater.W aterinanchor bolt holes shall be removed before grouting is started. Forms around base plates shall be reasonably tight to prevent leakage of the grout. Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place. Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact betweenbaseplateandfoundationandtohelpreleasetrappedair,linkchains canbeusedto work the grout into place. Grout throughout holes in base plates shall be by pressure grouting. Variations in grout mixes and procedures shall be permitted if approved by the Engineer-in-charge.

Non-ShrinkingGroutforEquipmentFoundation

Non-shrinking grout shall be used for grouting of machine base plates, anchor bolts, other anchoring devices and at locations where ordinary grouts are ineffective due to shrinkage. It shall be composed of a type of expansive hydraulic sheeting binder and select-graded aggregates. It shall have properties as per "*Table 11: Proportions for Non-Shrinking Grout*".

Table11:ProportionsforNon-ShrinkingGrout

S.No.	Properties	Values
1	Maximumgrainsize	6 mm
2	Water%(for80%flow)	15.17
3	Densityofhardenedgrout	2.27–2.30gm/m
4	CompressivestrengthN/sqmm	
	- Minimum3days	23
	- 7days	34

Mixing, batching, cleaning, preparation of surface and curing of non-shrinking grout shall be done as per manufacturer's instructions.

INSPECTION

a. All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer-in-Charge.
b. All materials supplied by the Contractor and all work or construction performed by the Contractor which is rejected as not being in conformity with the specifications and requirements, shall be immediately replaced.
c. All concrete shall be protected against damage until final acceptance by theEngineer-in-Charge.

CLEAN-UP

a. Upon completion of the concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.
b. All debris i.e. empty containers, scrap wood, etc., shall be removed

to “dump” daily, or as directed by the Engineer-in-Charge.

c. The finished concrete surfaces shall be left in a clean condition satisfactory to the Engineer-in-Charge.

RECORDSOFCONCRETING

An accurate and up to date record showing times, dates, weather and temperature conditions when various positions of all the concrete structures forming the works were concreted will be kept by the Engineer-in-charge and shall be countersigned by the Contractor. If the Contractor fails to sign the Engineer-in-Charge's record; it shall nevertheless be regarded as correct and binding on the Contractor.

The Contractor has to submit concrete pour card in duplicate duly to be signed to the Engineer-in-Charge for each type of concreting work. Contractor shall keep copy of it, after Engineer-in-Charge has checked and signed the pour card.

SUPPLYOF CEMENT

Contractorshallprocure/purchasethecement andshallbestackedandwell maintainedas specified in the earlier sections. Contractor shall procure cement in those quantities required for maximum one month of concreting work and more than the prescribed time limit is not allowed. For any damage to cement, PHED will not be responsible and the damaged cement will not be used in the work.

FOUNDATIONBEDDING,BONDINGANDJOINTING

a. All surfaces upon or against which concrete will be placedshall besuitablyprepared by thoroughly cleaning, washing and dewatering, as specified or as the Engineer-in- charge may direct, to meet the various situations encountered in the work.
b. Soft or spongy areas shall be cleaned out and backfilled with lean concrete or clean sand fill compacted.
c. Prior to construction of formwork for any item where soil will act as bottom form, approvalshall beobtainedfromtheEngineer-in-Chargeforthesuitabilityofthesoil.

PREPARATIONOFROCKSTRATAOFFOUNDATIONS

a. To provide tight bond with rock foundations, the rock surface shall be prepared and the following general requirements shall be observed.
b. Concrete shall not be deposited on large sloping rock surfaces. Where required bythe Engineer-in-charge, the rock shall be cut to form rough steps or benches to provide roughness or a more suitable bearing surface.
c. Rock foundation stratum shall be prepared by picking, barring, wedging and similar methods which will leave the rock in an entirely sound and unshattered condition.
d. Shortly before concrete is placed, the rock surface shall be cleaned with highpressure water and air jet even though it may have been previously cleaned in that manner.
e. Prior to placing concrete, the rock surface shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Engineer-in-Charge.
f. Before placing concrete on rock surfaces all water shall be removed fromdepressions to permit thorough inspection and proper bonding of the concrete to the rock.

EndofChapter5

CHAPTER-6

FORMWORK

FIXINGOFFORMWORK

All formworkshall beconstructedof plywood or sheet metal Plywood usedfor formwork shall beconformingtoIS:4990i.eSpecificationforplywoodfor concreteshutteringworks. The materials for form work shall got approved by the Engineer before starting the work. Form work shall be firmly supported, adequately strutted, braced and tied to withstand the placing and vibrating of concrete and the effects of weather. The tolerance on line and level shall not exceed 3 mm and the soffits of beams other than prestressed beams shall in the absence of any specified camber, be erected with an upward camber of 6 mm for each3 meters of span.

TheContractorshallberesponsibleforthecalculationsanddesignsforthefor mwork,andif required,shallsubmitthemtotheEngineerforapprovalbeforeconstruction onformworkto external faces which will be permanently exposed, all horizontal and vertical formwork joints shall be so arranged that joint lines will form a uniform pattern on the face of the concrete. Where the Contractor proposes to make up the formwork for standard sized manufactured formwork panels, the size of such panels shall be approved by the Engineer beforetheyareusedintheconstructionoftheWorks.Thefinishedappearanc eoftheentire elevation of the structure and adjoining

structures shall be considered when planning the pattern of joint lines caused by formwork and by construction joint to ensure continuity of horizontal and vertical lines. Faces of formwork in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all formwork shall be clean and free from standingwater,dirt,shavings,chippingsorotherforeignmatter.Jointsshall besufficiently watertight to prevent the escape of mortar or the formation of fins or other blemishes onthe face of the concrete.

Formwork shall be provided for the top surfaces of sloping work where the slope exceeds fifteen degrees from the horizontal (except where such top surface is specified as spaded finish) and shall be anchored to enable the concrete to be properly compacted and to prevent flotation, care being taken to prevent air being trapped.

Openings for inspection of the inside of the formwork and for the removal of water used for washing down shall be provided and so formed as to be easily closed before placing concrete.Beforeplacingconcrete,all bolts,pipesorconduitsor otherfixtureswhichareto be built in shall be fixed in their correct positions, and cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without approval of the Engineer.

All exterior angles onthefinished concrete of 90 degree or less shall be given 20 mmx 20 mm chamfers unless otherwise ordered by the Engineer.

No ties or bolts or other device shall be built into the concrete for the purpose ofsupporting formwork without the prior approval of the Engineer. The whole or part of any such supports shall be capable of removal so that no part remaining embedded in the concrete shall be nearer than 50 mm from the surface in the case of reinforced concreteand 150 mm in the case of un-reinforced concrete. Holes left after removal of such supports shall be neatly filled with well rammed dry-pack mortar.

Formwork in contact with the concrete shall be treated with a suitable non-staining mould oiltopreventadherenceoftheconcreteexceptwherethesurfaceissubsequentlytobe

rendered. Care shall be taken toprevent theoil fromcomingin contact with reinforcement or with concrete at construction joints. Surface retarding agents shall be used only where ordered by the Engineer.

REMOVALOFFORMWORK

Formwork shall be so designed as to permit any removal without resorting to hammering or levering against the surface of the concrete. The periods of time elapsing between the placing of the concrete and the striking of the loads likely to be imposed on the concrete and shall in any case be not less than the periods shown in Table below. Where soffit formwork is constructed in a manner during and after such removal of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may, with the agreement ofthe Engineer,remove theformworkatthe earliertimeslisted belowprovided that the props are left in position.

TABLE6.1

PositionofFormwork	**DaysforStriking**
Walls	1
Sidesofbeamsandcolumns	1
Slabs(Dropsleftunder)	3
Propstoslabs(spannotexceeding4.5 m)	7
Propstoslabs(spanexceeding4.5m)	14
Beamssoffits(propsleft under)	21

Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

Striking shall be done slowly with utmost care to avoid damage to projections and without shock or vibration, by gently easing the wedges. If after removing the form work it is found that timber has been embedded in the concrete. It shall be removed and made good as specified earlier.

Reinforced temporaryopenings shall be provided,as directed bytheEngineer,tofacilitate removal of formwork which otherwise may be inaccessible.

The rods, clamps, form bolts, etc. which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours not later than 40 hours after the concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and grade beams shall be pulled toward the inside face. Cutting ties back from the faces of the walls and grade beams will not be permitted.

For liquid retaining structures, no sleeves for through bolts shall be used nor shall through bolts beremoved asindicated above.Thebolts,inthiscase,shall becutat 25 mmdepthor more from the surface and then the hole shall be made good by cement sand mortar

of the same proportions as the concrete just after striking the formwork.

FORMEDSURFACES–CLASSESOFFINISH

Finishes to formed surfaces of concrete shall be classified as F1, F2, or F3, or such other special finish as may be particularly specified. Where the class of finish is not specifiedthe concrete shall be finished to Class F1.

Formwork for Class F3 finish shall be lined with as large panels as possible of non- staining material with a smooth unblemished surface such as sanded plywood or hard compressed fibre board, arranged in a uniform approved pattern and fixed to back formwork by oval nails. Unfaced wrought boarding or standard steel panels shall not be permitted.

Formwork for Class F2 finish shall be faced with wrought tongued and grooved boards or plywoodormetalpanelsarrangedinauniformapprovedpatternfreefromdefectslikelyto detract from the appearance of the surface.

Formworkfor Class F1finish shall beconstructedin sheet metal. Surfaces subsequentlyto be rendered, plastered or tiled shall be adequately scrabbled or hacked as soon as the formwork is removed to reduce the irregularities to not more than half the thickness of such rendering, plastering or bedding for tiles and to provide a satisfactory key.

DIFFECTSINFORMEDSURFACES

Workmanship in formwork and concreting shall be such that concrete shall normally require no making good, surfaces being perfectly compacted and smooth.

If any blemishes are revealed after removal of formwork, the Engineer's decisions concerning remedial measures shall be obtained immediately. These measures may include, but shall not be limited to the following:

i) Fins, pinhole bubbles, surface dis-coloration and minor defects may be rubbed down with sacking immediately after the formwork is removed.

ii) Abruptandgradualirregularities mayberubbeddownwithcarborundumandwater after the concrete has been fully cured. These and any other defects shall be remedied by methodsapprovedbytheEngineerwhichmayincludeusingasuitableepoxyresinor, where necessary, cutting out to a regular dovetails shape at least 75 mm deep and refillingwithconcreteoversteel meshreinforcementsprungintothedovetail.

HOLESTOBEFILLED

Holes formed in concrete surfaces by formwork supports or the like shall be filled with dry-packmortarmadefromonepartbyweightofordinaryPortlandcementandthreeparts fine aggregate passing IS sieve 1.18 mm. The mortar shall be mixed with only sufficient water to make the materials stick together when being moulded in the hands.

Thecontractor shallthoroughlycleananyholethatistobefilledwithdry-packmortar and where the surface has been damaged, the contractor shall break out any loose, broken or cracked concrete or aggregate. The concrete surrounding the hole shall then be thoroughly soakedafterwhichthesurfaceshall bedriedsoastoleaveasmall amount offreewateron thesurface.ThesurfaceshallthenbedustedlightlywithordinaryPortlandcementbymeans of a small dry brush until the whole surface that will come into contact with the dry-pack mortar has been covered and darkened by absorption of the free water on the surface. The surface shall then be dusted lightly with ordinary Portland cement by means of a small dry brush until the whole surface that will come into contact

With the dry-pack mortar has been covered and darkened by absorption of the free water by the cement. Any dry cement in the hole shall be removed.

The dry-pack material shall then be placed and packed in layers having a compacted thicknessnotgreaterthen15mm.Thecompactionshallbecarriedoutbyuseo fahardwood stick and a hammer and shall extend over the full area of the layer, particular care being taken to compact the dry-pack against the sides of the hole. After compaction, the surface of each layer shall be scratched the dry-pack fill and striking the block several times. Steel finishing tools shall not be used and water shall not be added to facilitate finishing.

TOLERANCES

Tolerance is a specified permissible variation from lines, grade or dimensions given in approved drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerances will be permitted:

TolerancesforRCCStructures

i) Variationfromthe plumb
   a) In the lines and surfaces of columns, piers, walls 5 mm per 2.5 m or 25mm, whichever is less.
   b) Forexposedcornercolumnsandotherconspic uouslines In any bay or 5 m maximum 5 mm
      In10mormore 10mm

ii) Variationfromthelevelorfromthegradesindicatedontheapproveddrawings
   a) Inslabsoffits,ceilings,beamsoffit,andin arises In 2.5 m 5 mm
      In any bay or 5 m maximum

      10mm In10mormore

      15mm
   b) Forexposedlintels,sills,parapets,horizontalgroovesandother conspicuous lines
      In any bay or 5 m maximum 5
      mm In 10 m or more

      10mm

iii) Variation of the linear buildinglinesfromestablished positionin plan and related position of columns, wall and partitions
   Inanybayor5mmaximum 10mm
   In10mormore 20mm

iv) Variation in thesizesand locationsofsleeves,openingsinwallsandfloors
   Except in the case of and for 5 mm anchor bolts

v) Variationincrosssectionaldimensionsofcolumnsandbeamsandinthet hicknessof slabs and walls

Minus	5 mm
Plus	10mm

vi) Footings

a) Variationindimensioninplan

Minus	5mm
Plus	10mm

b) Misplacementoreccentricity

2%offootingwidthinthedirectionofmisplacementbutnotmor ethan50 mm

c) Reduction inthickness
Minus5%ofspecifiedthicknesssubjecttoamaximumof50 mm

vii) Variationinsteps

a) Inaflightofstairs

Rise	3mm
Tread	5mm

b) Inconsecutivesteps

Rise	1.5mm
Tread	3 mm

TolerancesinotherConcreteStructures

viii) Allstructures

a) Variationoftheconstructedlinearoutlinesfromestablishedpo sitioninplan In 5 m 10mm
In10mormore 15mm

b) Variationsofdimensionstoindividualstructuralfeaturesfrom established positions
In20mormore 25mm
Inburiedconstruction 50mm

c) Variation from plumb, from specified batter or from curvedsurfaces of all structures
In2.5m 10mm
In5m 15mm
In10mormore 25mm
InburiedconstructionTwicetheabove amounts

d) Variationfromlevelorgradeindicatedonapproveddrawingsi nslab, beams, soffits, horizontal grooves and visible arises
In2.5m 5mm
In7.5mormore 10mm
InburiedconstructionTwicetheabove amounts

e) Variationincross-sectionaldimensionsofcolumns,beams,buttresses, piers and similar members

Minus	5 mm
Plus	10 mm

ix) Footingsforcolumns,piers,walls,buttressesandsimilarmembers

a) Variation of dimensions in
plan Minus 10
mm
Plus 50 mm

b) Misplacementoreccentricity
2%offootingwidthinthedirectionofmisplacementbutnotmor ethan50 mm.

c) Reduction inthickness
5%ofspecifiedthicknesssubjecttoamaximumof50mm

x) Tolerance in other types of structures shall generally conform to those given in Clause 2.4 of Recommended Practice for Concrete Formwork (American Concrete Institute Act 347).

xi) Toleranceinfixinganchorboltsshallbeasfollows:

a) Anchor bolts without + 5 mm sleeves

b) Anchorboltswith +5mmforbolts sleeves

upto20mmdia

+3mmforboltsabove32mmdia

c) Embeddedparts +5mminalldirections

BRACING,STRUTSANDPROPS

Formwork shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboos shall not be used as props or cross bearers.

The formwork for beams and slabs shall be so erected that the formwork on the sides ofthe beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Re-propping of beams shall not be done except when props have to be reinstated to take car of construction loads anticipated being in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the propscan be gently lowered vertically while striking the formwork.

If the formwork for a column is erected for the full height of the column, one side shall be leftopenandbuiltupinsectionsasplacingoftheconcreteproceeds,orwindo wsmaybeleft for pouringconcrete fromthe sides tolimit the dropofconcreteto 1.0 mas directed bythe Engineer.

TECHNICALSPECIFICATIONSFORSHEETPILING

GENERAL

Sheetpilingisaformofdrivenpilingusinginterlockingsheetsofsteelt oobtaina continuous barrierinthe ground.The main applicationof sheetpileisin retaining
walls erected for the purpose of excavation to enable permanent works to proceed. Normally vibrating hammer/ impact hammer, crane and crawler drilling are to be used to establish sheet piles.
The work shall include supply, installation and subsequent removal of all
miscellaneoussteelshapes,platesandconnectinghardwarewhe nrequiredto attach the sheeting to an existing substructure unit and/or facilitate stage construction.

All initial banking has to be formed at contractor's own cost for taking the machinery to drive the sheet piles. The area shall be filled driving of steel sheet piles with pit sand for leveling the ground.

Piles shall be driven, true to plumb and alignment. Hammer for sheet

pile driving shall be drop hammer, steam hammer, air hammer, diesel hammer or vibratory hammer. Sheet pile driving shall commence initially with minimum impact of hammer, which can beincreasedlaterafterensuringthatthepilesarebeingdrivenverticallythrough the

interlocking grooves along with designed alignment. The sheet piles are to be driven with batten welded at suitable intervals. The Steel Sheet Pile may be lifted at single point.

APPLICABLECODE

AllworkshallbecarriedoutstrictlyinaccordancewiththeTechnicalSpecifications, unless otherwise approved by Engineer-In-Charge in writing. The Indian Standard Codes applicable to this section shall include but not limited to the following.

INDIANSTANDARDS(ISCODES)

IS 2314:1986

Specificationforsteelsheetpilingsections(firstrevision)

AMERICAN SOCIETY FOR TESTING AND MATERIALS

(ASTM)

ASTMA6/

A6M(2000)GeneralRequirementsforRolledStructuralSteelBars,

Plates, Shapes, and Sheet Piling

ASTMA328/A328M(200)SteelSheetPiling

ASTMA572/A572M(200)High-StrengthLow-AlloyColumbium-

Vanadium Structural Steel

ASTMA690/A690M(1994)High-StrengthLow-AlloySteelH-

Pilesand Sheet Piling for Use in Marine Environments

ASTMA857/A857M(1997el)SteelSheetPiling,ColdFormed,Light Gage.

TRANSPORTATION:

The Contractor shall set up, in accordance with the construction schedule make all the necessary arrangements for hauling of all materials for the steel sheet pile driving so that all the materials will be available for immediate use whenever required:

a) Allthesteelsheetpilesshallbedeliveredintactatthesitewithoutcausing any permanent distortion in the member or injury or deformation at joints.

b) Careshallbetakeninhandlingsuchmaterialsastie-

rodstoavoiddamagetothe thread and shop coat painting.

c) Handling of such long members as walling shall be carried out in the same way as for the steel sheet piles.

STORAGE:

a) Storage space for steel sheet piles shall be reasonably leveled andcompacted. The site so selected should be got approved by the ENGINEER.

b) Steel sheet piles shall be stacked in such a way as to avoid strain or distortion in the materials.

c) Steelsheet pilesshall be stacked upinsuchtiersas each consistingofnot morethan 3 piles, and between each tier wooden sleepers shall be inserted at intervals not exceeding 4m. Total height of stack shall not exceed 2m.

d) Tie-rods and accessories shall be sorted, stacked in accordance with their diameters and shall be stored under cover and not be directly exposed to weather.

e) TheContractorshallberesponsible for safe handling, mobilization & demobilization and storage of piles and other materials. The rate for sheet pile driving shall include the cost for handling and storage of piles and other accessories, forming driving pit, formation and removal of earthen bund if required, all other requisites for successful driving of sheet pile.

CUTTINGOFSHEETPILE:

a) Cuttingofsteel sheetpilesshall bedonebymeansofagascuttingdevice.

b) Steel sheet piles to be cut shall be free fromcurve and warp, and securely clamped on a level work table for cutting.

c) Useofaspecialjigisdesirabletominimizedeformationdueto cutting

d) Whatever method is used in cutting, a certain degree of deformation is bound tooccur. If the deformation is less than 40mm, it can be set right by hammering or by heat treatment to the deformed segment. If the deformation exceeds the above range, mechanical correction by means of jacks and press shall be made.

SHEETPILE WELDING:

a) Arcweldingshallbeadoptedforsteelsheetpilework.

b) OnlyskilledweldersapprovedbytheENGINEERshallbeengagedforthework.

c) Welding equipment shall be AC rectifiers / arc-welding unit. Welding rods shall be those conforming to the relevant IS or equivalent and subject to prior approval of ENGINEER.

d) If any welding is rejected by the ENGINEER, the Contractor shall perform the welding again by cutting off at the weld at his cost. All the costs thereof shall beborne by the Contractor.

MATERIALS

MetalsheetpilingmaterialshallbeconformingtoIS-2314orequivalentASTM standards.The interlocks of sheet piling shall be free-sliding, provide a swing anglesuitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed. Sheet piling [including special abricatedsections]shallbe[full-

length]sectionsofthedimensionsasshowninthedrawing. Sheet piling shall be provided with standard pulling holes.

Metalplates,shapes,bolts,nuts,rivets,andotherappurtenantfabricationand

installationmaterialsshallconformtomanufacturer'sstandardsandtot
he requirements specified in the respective sheet piling.

EXTRACTIONOFREJECTEDSHEETPILE:

If the pile driving work has not been done to the specification, the Contractor shall extract the rejected pile. The extraction shall be such as to avoid damages to the adjoining piles, other structures and installations. Cost of extraction and replacement shall be borne by the Contractor.

CONSTRUCTION

The Contractor shall verify locations of all underground utilities before driving any sheet piling. Any disturbance or damage to existing structures, utilities or other property, caused by the Contractor’s operation, shall be repaired by the Contractor in a manner satisfactory to the Engineer at no additional cost to the Department. The Contractor shall beresponsible for determining the appropriate equipment necessary to drive the sheeting to the tip elevation(s) specified on the plans or according to the Contractor’s approveddesign. The Contractor shall be responsible for determining the appropriate equipment necessaryto drive the sheetingto the tip elevation(s) specified on the plans or accordingto the Contractor’s approved design. The sheet piling shall be driven, as a minimum, to thetip elevation(s) specified, prior to commencing any related excavation. If unable to reach the minimum tip elevation, the adequacy of the sheet piling design will require re- evaluation by the PMC/ Owner prior to allowing excavation adjacent to the sheet piling in question.The Contractor shall not excavate belowthemaximumexcavation line shown on the plans without the prior permission of the Engineer. The sheet piling shall remain in place until the Engineer determines it is no longer required.

ThesheetpilingshallberemovedandtakeawayfromsitebytheContractorwh
en directed by the Engineer. When allowed, the Contractor may elect to cut off a portion of the sheet piling leaving the rest in place. The remaining piling shall be a minimum of 12 in. (300 mm) below the finished grade or as directed by the Engineer. Removed sheet piling becomes the property of the Contractor. When an obstruction is encountered, the Contractor shall notify the Engineer and upon concurrence of the Engineer, the Contractor shall begin working to break up, push aside, or remove the obstruction. An obstruction shall be defined as any object (such as but not limited to, boulders, logs, old foundations etc.) where it’s presence was not obvious or specifically noted on the plans prior to bidding, that cannot be driven through or around with normal driving procedures, but requires additional excavation or other procedures to remove or miss the obstruction.

Thefollowingaretheinstallation procedure:-

1 Thealignmentofsheetpilewallshallbecorrectlysetupfortheapprovaloft

he ENGINEER before commencing the sheet pile driving.

2 Guideframesandstakesshallbeinstalledcorrectlyandsecuredproperlyt oensure driving of piles on the centre line.

3 Steelsheetpiledrivingshallbeperformedbyoneofthefollowingmethods:

a) In driving single pile one by one, special care shall be exercised to keep each pile penetrating in strictly vertical direction.

b) In driving a group of piles (about 20 pieces simultaneously) a guide frame shall be used to keep them in a straight alignment, and in the initial stage all the piles shall be driven to a depth just enough to enable them to stand in positions. Then one or two pieces on both ends shall be driven down first, followed by the intermediate piles which shall be driven alternately in several stages to final level.

4 Hammer for steel sheet piling shall be drop hammer, steam hammer, air-hammer, diesel hammer, electric vibratory hammer and vibro-hammer. Before employing a driving hammer, Contractor shall obtain approval of the ENGINEER for its use in the job.

5 Prior to starting pile driving, the Contractor shall submit the driving method and time schedule for approval of the ENGINEER and in accordance with the sequence approved by the ENGINEER. The piles shall be driven vertically in the specified positions.

6 Piledriving:

Sheet pile driving shall commence initially with minimum impact of hammer and increased later after ensuring that the piles are being driven vertically in designed alignment.

Pile shall be driven with cap and cushion on top of the pile for protection against the impact of drop hammer.

Lengthening of pile, if required, shall be done by welding additional piece on to thetop of pile already driven. The joints shall be as strong as the normal section of the pile.

In case interlocks of piles with adjacent ones are found loosened or dislocated during or after driving, such piles shall be pulled out and replaced with new ones or redone otherwise in accordance with instructions of the ENGINEER.

The Contractor shall take every step to ensure safety and to prevent accident while handling and driving piles. If any deviation from specified lines, fractured top, deficient or excessive penetration is observed during pile driving, the driving shall be suspended to take corrective measures as directed by the ENGINEER.

Necessary data and logs such as of the number of blows, length of penetration etc. during sheet pile driving shall be made and submitted in duplicate to the ENGINEER at no extra cost. Format of driving log shall be got approved by ENGINEER prior to commencement of driving sheet piles

7 Reformedsteelsheet piles:

Reformed steel sheet piles shall be of three types, namely corner sheet pile, junction sheet pile and wedge sheet pile.

Corner sheet piles are used where centre line for driving turns to form an angle, and joined by welding to the sheet pile wall that has changed its direction.

Junction sheet piles are those to be used where two walls of sheet piles meet at right angle forming a T junction, and where the sizes of sheet pile change along the same line.

Wedge sheet piles are used to make up for the deviation of piles from the plumb line caused during driving. This type of pile is characterized by its wedge like shape, tapering downward to the tip.

Reformed steel sheet piles as mentioned above shall as a rule is manufactured in a factory. If it becomes inevitable to fabricate them in the field at site, the Contractor shall provide equipment and manufacturing means equivalent to those of the regular factory production and have close supervision and control over driving.

If the Contractorfindsitnecessarytousethereformed steelsheet piles, heshallobtain approval of the ENGINEER for the use, and fabricate the same at his own cost in accordance with the instructions of the ENGINEER.

PAYMENTFORSTEELSHEETPILING:

The Contractor shall be paid for the net area of the steel sheet piles actually driven in the workinaccordancewiththeContractdrawingsorasdirectedbytheENGINEER. Theunit rate for steel sheet pile driving shall include the costs of material, transportation, driving and incidental costs towards replacement of the damaged steel sheet piles. The cost will also include the cost of waling and accessories. While paying the unit cost under this item, deduction of 10% of the unit rate under sub-item of Sl no 1 of BOQ, (Earthwork) will be made towards Shoring and Strutting provision made in the relevant excavation sub items which is analyzed based on the practical experience and rate analysis of excavation of trench

EndofChapter6

CHAPTER-7

REINFORCEMENT

GENERAL

Reinforcement shall be Thermo Mechanically Treated Fe 500 Bars as per IS: 1786. Wire mesh or fabric shall be in accordance with IS:1566. Substitution of reinforcement will not be permitted except upon written approval from the Engineer.

STORAGE

The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like.

If the reinforcing rods have to be stored for a long duration, they shall be coated with cement wash before stacking and/or be kept under cover or stored as directed by the Engineer.

Fabricated reinforcement shall be carefully stored to prevent damage, distortion,corrosion and deterioration.

QUALITY

No re-rolled material will be accepted. If requested by the Engineer, the contractor shall submitthemanufacturer'stestcertificateforthesteel.Randomtestsonsteel suppliedbythe contractor may be performed by the Engineer as per relevant Indian Standards. All costs incidental to such tests shall be at the contractor's expenses. Steel not conforming to specifications shall be rejected.

Allreinforcementsshallbeclean,freefromgrease,oilpaint,dirt,loosemillscale,looserust, dust bituminous material or any other substances that will destroy or reduce the bond. All rodsshallbethoroughlycleanedbeforebeingfabricated.Pittedanddefectiverodsshallnot be used. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer. If weldingisapproved,theworkshall becarriedout asper IS:2751accordingto the best modern practices and as directed by the Engineer. In all cases of important connections, tests shall be made to prove that the joints are of full strength of bars welded. Special precautions, as specified by the Engineer, shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

Laps and splices for reinforcement shall be as per IS:456. Splices in adjacent bars shall be staggered and the locations of all splices shall be approved by the Engineer.

BENDING

Reinforcementbarssuppliedbentorincoils,shallbestraightenedbeforethe yarecuttosize. Straightening of bars shall be done cold and without damaging the bars. All bars shall be accurately bent according to the sizes and shapes shown on the approved detailed working drawings/barbendingschedules.Theyshallbebentgraduallybymachineor otherapproved means.Reinforcingbarsshallnotbestraightenedandre-bentinamannerthatwillinjurethe material;barscontainingcracks/splitsshallberejected.Theyshallbebentco ld,exceptbars ofover25mmindiameterwhichmaybebenthotifspecificallyapprovedbythe Engineer. Bars which depend for their strength of cold working shall not be bent hot. Bars bent hot shallnotbetreatedbeyondcherryredcolour(norexceeding845C)andafterb endingshall beallowedtocoolslowlywithoutquenching.Barsincorrectlybentshallbeuse donlyifthe means used for straightening and re-bending be such as shall not, in the opinion of the Engineer, injure the material. No reinforcement shall be bent when in position in the work withoutapproval,whetherornotitispartiallyembeddedinhardenedconcret e.Barshaving kinks or bends other than those required by design shall not be used.

FIXING

Reinforcementshallbeaccuratelyfixedbyanyapprovedmeansandmaintaine dinthecorrect position shown in the approved Drawings by the use of blocks, spacers and chairs, as per IS:2502,topreventdisplacementduringplacingandcompactionofconcrete. Barsintendedto beincontactatcrossingpointsshallbesecurelyboundtogetheratallsuchpoint swithnumber 16gaugeannealedsoftironwire.Theverticaldistancesrequiredbetweensucc essivelayersof barsinbeamsorsimilar membersshallbe maintained bytheprovisionof mildsteelspacer barsatsuchintervalsthatthemainbarsdonotperceptiblysagbetweenadjacen tspacerbars.

NOMINALCOVERTOREINFORCEMENT

Nominal cover is the design depth of concrete cover to all steel reinforcements, including links. It is the dimension used in design and indicated in the drawings. It shall be not less than the diameter of the bar.

Minimumvalues for the nominal cover of normal weight aggregate concrete which should be provided to all reinforcement, including links depending on the condition of exposure described in Clause-8.2.3 and as given in Table –16 of IS:456/2000.

Howeverforalongitudinalreinforcingbarinacolumnnominalcovershallina nycasenot be less than 40 mm, or less than the diameter of such bar. In the case of columns of minimum dimension of 200 mm or under, whose reinforcing bars do not exceed 12 mm, a nominal cover of 25 mm may be used.

Forfootingsminimumcovershallbe50mm.

Table-16ofIS:456/2000–NominalcovertoMeetDurabilityRequirements

Exposure	**NominalConcretecoverinmmnotlessthan**
Mild	20
Moderate	30
Severe	45
Verysevere	50
Extreme	75

The correct cover shall be maintained by cement mortar cubes or other approved means. Reinforcementforfootings,gradebeamsandslabsonsub-gradeshallbesupportedonpre-caseconcreteblocksasapprovedbytheEngineer.Theuseofpebblesorstone sshallnotbe permitted. The 28 days crushing strength of cement mortar cubes/pre-cast concrete cover blocks shall be at least equal to the specified strength of concrete in which these cubes/blocks are embedded.

The minimum clear distance between reinforcing bars shall be in accordance with IS:456.

INSPECTION

Erected and secured reinforcement shall be inspected and approved by the Engineer prior to placement of concrete.

WELDINGOF REINFORCEMENT

Reinforcement which is specified to be welded shall be welded by any process which conforms with the requirements of IS:2751 and which the Contractor can demonstrate by bend and tensile tests will ensure that the strength of the parent metal is not reduced and that the weld possesses a strength not less than that of the parent metal. The welding procedure established by successful test welds shall be maintained and no departure from this procedure shall be permitted.

Welds in positions other than those shown on the approved Drawings shall not be permitted. Tack welding to lightly secure reinforcement in place will be permitted subject to approval of the Engineer.

SUPPLYOFREINFORCINGBARS

Contractor shall make their own arrangements for the supply of steel reinforcement, MS bars/high yield strength deformed bars etc. required for the works. Further, the Contractor shall be responsible for payments of applicable duties and taxes etc.

EndofChapter7

CHAPTER8

SEWERAPPURTENANCES

MACHINEHOLE

Themachineholes shall beprovidedwith Pre cast orCast insitu RCC machineholes depending upon diameter of sewers and depending upon the alignment of proposed sewer whether it is on road or in Storm Water Drain (SWD) or as directed by Engineer Incharge

TheRCCmachineholearedefinedwiththefollowingconditions.

- RCCmachinehole–900mmdia.pipeandaboveforalldepths
- RCCmachinehole–InSWD,foralldia.ofpipeandforalldepths.

TheBrickMachineholeshallbeconstructedasperIS4111-Part-1

(i) Location

Machineholeshallbeconstructedatplacesasshownonrelevantdrawingsand as

directedbytheEngineer-in-charge.

(ii) Excavation

Excavation,shoring,dewateringetc.forthepitsofmachineholeshallbe done in

accordancewithspecification.

(iii) CementMortar

Mortar for brick masonry shall be prepared as per IS: 2250. Machine hole shall be constructed in brick masonry with cement mortar (1:4), 20 mm thick inside plaster and 12 mm thick outside plaster in CM 1:3, unless otherwise specified in items. Gauge boxes for sand shall be of such dimensions that one bag containing 50Kg.ofcementformsoneunit.Thesandshallbefreefromclay,shale,

loan,

alkaliandorganicmatterandshall beof sound,hard,cleananddurableparticles. Sand shall beas approved byEngineer. If so directed bythe Engineer, sand shall be thoroughly washed, till it is free of any contamination.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

Contractor shall arrange fortest on mortar samples if so directed bythe Engineer. Retempering of mortar shall not be permitted.

(v) CementPlaster

All joints in masonry shall be raked to a depth of 12 mm. with a hooked toolmade for the purpose when the mortar is still green and in any case within 46 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be renderedwill however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond betweenthe plaster and the wall.

The proportion of the cement mortar shall be as specified on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shallbeasperrelevantI.S.Themortarthusmixedshallbeusedimmediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

Curing of plaster shall be started as soon as the applied plaster has hardened enoughsoasnottobedamaged.Thedecisionastowhentheplasterhas hardened will be given by the Engineer-in-charge. Curing shall be done by continuously applying water in fine spray and shall be carried out for at least 7 days.

Plastering shall be done on both faces of brick masonry, 20 mm thick inside and 12 mm thick outside.

The machine hole shall be internally provided with **PVC/Poly Urea lining of thickness 1.5 mm** to protect the walls and top from corrosion developed due to sewer gases such as H2S etc.

(vii) Cementconcretechannel

The channel for the machine holes shall be constructed in cement concrete of M25 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete extended vertically 50mm above and rendered in cement mortar (1:2) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

The branch channels also be similarly constructed with respect to the benching but at their junctions with main channel, an appropriate fall, if required suitably rounded off, in the direction of flow in main channel shall be given.

The machine hole shall be constructed at places shown on the drawings or wherever directed by the Engineer.

(viii) Pipeenteringorleavingmachineholes

Whenever a pipe enters or leaves a machine holes, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch.All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

(ix) Rungs/footsteps

Rungs / footsteps shall be provided in all machine hole and shall be Manufacture and conforms to the dimensions of IS 5455:1969(RA1977) are reinforcement encapsulated with PVC. The surface finish shall have 2mm tread on top by ribbing or chequering. These rungs may be 300 mm apart vertically and shall project a minimum of 100 mm beyond the finished surface of the machine holes wall. The top rung shall be 450 mm below the machine holes cover and thelowest not morethan300mmabovethebenching.Rungsshall betestedasper IS and approved before usage.

(x) Frameandcovers

Frame and covers for machine hole shall be of required type and dimensions as per the relevant drawings.

Followinginformationshallbeclearlymarkedoneachcover.

a. Yearof manufacture
b. Identificationmarkofthepurchaser
c. SEWER/SWD
d. Arrowshowingdirectionof flow
e. Nameofmanufacturer/Trademark

(xi) SteelFibreReinforcedConcrete(SFRC)FrameandCover

Steel Fibre Reinforced Concrete (SFRC) frame and cover shall be as manufactured as per IS 12592. (Latest edition). The contractor to submit the structural design and drawing of frame and cover and get it approved before manufacturing the same.

(xii) DropMachineholes

When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) of main line and the invert level of branch line is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a machine holes shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher

sewer to the lower one. This pipe shall be provided outside the shaftandencasedinconcrete.Acontinuationofthebranchsewersho uldbe built

through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer

(xiii) RCCMachineholes

In general, plain and reinforced concrete work for machine hole shall be carried out in accordance with the specification and drawing.

(xiv) Measurement Machinehole

The depth of machine holes shall be measure from the top of cover to the invert level of the deepest outgoing sewer from the machine holes. The relevant items of machine holes quoted in schedule of quantities and drawings. The measurement shall be per number basis and as per the actual depth of machine holes constructed.

EXISTINGCONNECTIONS

All existing connections which are removed during the uprooting of the existing sewer shall be replaced and reconnected with new sewer as per the directions of the Engineer. The replaced new sewer connections shall be properly laid, jointed and connected as per the directions of the Engineer. During the execution work of replacing sewer if the bedding of the connection has been disturbed it shall be replaced with new bedding asper specification contained in the tender document. After making the connection to the sewer, back filling shall be done in layers as directed by the Engineer.

VENTILATIONSHAFTS

Ventilation shafts areto beprovided for themachine hole in SWDas shown in drawing. The connecting pipe from machine holes to ventilating shaft should be DI K-9 150 mm diameter. A foundation block of 150mm thick PCC in M15 is provided surrounding the pipe. The vertical shaft should be made of ductile iron and it should be around 6 m high above the ground level and the internal diameter of the shaft should be 150 mm. All the dimensions are to be taken as per tender drawing. The joint of pipes forming the ventilatingshaft shouldbemade air tight.The locationof the ventilatingshaft should be such that it should not cause any nuisance to the vehicular traffic and the movement of pedestrians. The placing of ventilating shaft should be as per the directions of Engineer in charge. The details of fixing the ventilating shafts are provided in the drawing given in the tender document. The ventilating shafts if required shall be informed by Engineer In charge

NEWHOUSECONNECTIONS

The new house connections along the side of the storm waterdrain and the existing sewerconnectionsconnectedatpresenttothestormwaterdrainshallbe disconnected to the storm water drain and be connected to the newly replaced sewer. Whiledoingsothecontractorhastodismantlethestormwaterdrainforthen ew

connection. After properly connecting the above connections to the new replacedsewer, contractor shall reconstruct all the broken storm water drains and the rate for makingthenewconnectionsshallalsoincludetherectificationofstormwater drains.Ifthenumbersofconnectionsaremoreinaparticularstretchcontactorshall put a rider main along the side of storm water drain and connect it to the nearest D/S machine holes. Separate payment will be made as per Bill of Quantities for the rider main.Therefore thecontractorshallinformtheengineerwellinadvanceabout the new connectionsorexisting connections to theEngineer and theEngineer'sdecision forabovetwoalternativesshallbefinalandbindingonthecontractor.

CONCRETECRADLES,HAUNCHING,ETC.

The concrete cradles shall be constructed in situ by the contractor, indicated in the drawings, in places wherever required as decided by the Engineer.

Notes

If any damage is caused to the other services such as water supply pipeline, sewer, cable etc. during the construction of machine hole Contractor shall be held responsible for the same and shall replace the damaged services at his own cost to the full satisfaction of the Engineer.

Theinterior of machine hole shall be cleared of all debrisafter constructionand before testing the same for water tightness by Contractor at his own cost.

Water for testing of machine hole along with pipeline shall be arranged by Contractor at his own cost.

CHAPTER9

SPECIFICATIONFORSFRCMACHINEHOLESCOVERS

SCOPE

Contractor's scope includes the design, manufacture, supplying and fixing the FRC machineholesframeandcovers.Thewetconcretemixissubjectedtopressureapplied through a hydraulic jack through a plunger kept at the top of the wet mix. The FRC machine holes covers shall be able to resist 35 tonnes load bearing capacity. The thicknessoftheheavydutymachineholescoversshallnotbelessthan10.5cm.A25x3 mm thick MS Flat all around the frame is welded to the main reinforcement of the framesoastogetaclearopeningof600mmdiameter.A18SWGMSstrapallaround the cover and lifting arrangement of 12 mm diameter MS bars welded to the main reinforcementare also tobe provided for liftingthe machineholes covers. Acoat of epoxypaintshallbeappliedtotheundersideandsidesoftheframeandcover.

GENERAL

a) The quality of materials, method of testing shall be approved by the Engineer in Charge.

b) TheEngineershallhavetherighttoinspectthesource/sofmaterial/s,thelayoutand procurement, the equipment, quality control system, testing of material etc. If the Engineer desires the sample of the FRC cover or materials usedfor the manufacture of FRC covers, test certificate from approved laboratory. Then the

contractor shall arrange the same without any extra cost.

MATERIAL

a) Cement

Unless otherwise specified in the specification or called for the engineer, cement shall be ordinary Portland cement as per the relevant IS code. More details are mentioned on the section of concrete under this tender document.

b) Fineaggregates

The details of this have been mentioned in the section concrete and allied works of this tender document.

c) Coarseaggregate

Coarse aggregate for concrete, shall conform to IS 383. This shall consist of crushedstone and shall beclean and free fromelongated flakyor laminatedpieces, adhering coating, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter, The maximum size of the aggregate shall be 12 mm .

d) Water

Water for use in concrete and curing shall conform to IS 456/1964 and its subsequent amendments.

e) Water/cementratio

The water-cement ratio shall *be 0.40 to 0.45 to* yield a good workability. The workability can be increased by using appropriate admixtures.

f) FiberReinforcement

The fibers are cut from0.40 mmdia high tensile steel wires of about 12000 kg/cm2 ultimate stress. The fiber content for the manufacture of FRC covers is of the order1 to 1.25% by volume of the concrete.

g) DesignMix

The vendor shall design the mix design of the concrete which is expected to give a concrete compressive strength of about 350 kg/cm^2 at 28 days.

h) Mixing

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until thereisauniformdistribution ofthe materials andthemass isuniformincolourand consistency.

i) PlacingandCompaction

The reinforcement shall be placed in proper position in steel moulds coated with a thin layer of mould oil. Concrete shall be filled to slightly overfill the moulds and compacted by vibration

and struck off level with a trowel.

Use of needle vibrators for compacting the wet concrete mix containing fibres isnotrecommendedsincetheholesleftbythevibratorinthewetmixmay not closeafteritsremovalowingtointerlockingofthefibreswiththemix. Compactionbymeansofshutterorform ortablevibratorsisrecommended.In case of extra heavy duty and heavy duty cover frames, compaction by means of pressurecum-vibrationtechniquemayalsobeemployedsoastoachievedense and strong concrete. Clear cover to reinforcement shall be not less than 15 mm. After de-moulding, cover frames shall be protected until they are sufficiently hardened to permit handling without damage.

j) Curing

Thehardenedconcretemachineholescoverframeshallbeplacedinacuring water tank or taken to the curing yard where they shall be kept continuously moist for at least 28 days. Frames may be water cured by immersion in water, covering with water saturated material or by a system of perforated pipes. Mechanical sprinklers or any other approved method that will keep covering frames moistduring the specified curing period. Steam curing of machine holes cover framesmay be adopted instead of method specified above provided the requirements of pressure or non pressure steam curing are fulfilled and the machine holes cover frames meet the requirements specified in this section.

k) EdgeProtectionandFinishing

Thetopandinsidesurfaceofcover framesshall besmooth.Toprevent thetopouter edge from possible damages, it shall be protected by 25 mm x 3 mm mild steel flat as part of the frame. Sufficient number of steel connectors shall be welded to the inner surface of the mild steel flat so as to connect it with the frame reinforcement andtheseshall beembeddedintheconcreteduringcasting.Exposedsurfaceofmild steel flat shall be given suitable treatment with anticorrosive paint or coating. Suitable arrangements may be made for fixing the machine holes cover frames in position on the machine hole by mutual agreement between the manufacturer andthe purchaser.

l) Physicalrequirements GENERAL

All the frames shall be sound and free from cracks and other defects whichinterferes with the proper placing of the units or impair the strength or performance of the units.Minor chippings resulting fromthe customary methods of handlingand transportation shall not be deemed ground for rejection.

m) Dimensions

Theinsidedimensionsattopshallmatchwiththecorrespondingcovers sothat themaximumclearanceattopbetweentheframeandthecoverisnotmorethan 5mmandthetopsurfaceoftheframeandcoverisinlevelwithinatoleranceof

.±5mm.

h)

ScaleofSampl

ing LOT

In a consignment 500 precast concretemachine holes cover frames or a parthereof,ofthesametypeanddimensionsandbelongingtothesame batchof

manufacturer, shall be grouped together to constitute a lot For ascertaining conformitytothematerialsinthelottorequirementsofthisspecification, samplesshallbetestedfromeachlotseparately.Thenumberofcoverframesto beselectedfromthelotshalldependonthesizeoflotandshallbeaccordingto the following table:

SCALEOFSAMPLINGANDPERMISSIBLENUMBEROFDEFECTIVES

No.ofcoverFramesintheLotDimensionalRequirement

	SampleSize	**AcceptanceNumber**
Upto100	10	1
101 to200	15	1
201 to300	20	2
301 to500	30	3

CHAPTER10

RCC SOCKETSPIGOTNON-PRESSUREPIPES

GENERAL

RCC NP3 and RCC NP4 class pipes shall be used as per the requirement. These pipes shall be in accordance with the specifications mentioned in IS:458-2003 and its Amendments. Further, the Contractor can use other materials like DI/HDPE etc. with the prior consent of the Employer along with sufficient evidence for proof that the materials which he is proposing for substitution willresult in higher performance than the one whichis mentioned.These proposed pipes shall be in accordance with the specifications mentioned in relevant IS and for which no extra cost other than the one which is mentioned in BOQ will be paid.

MATERIALS

Forpre-castreinforcedconcretepipes,materialscomplyingwiththerequirementsgivenin(i)to(v)shallbeused.

i) Cement

Cementused for 1000mm andabovesizeRCC NP3 pipes shall bemanufacturedwith Sulphate Resistant Cement and conforms to 12269:1987 (RA2004).

Cement used for up to 900mm size RCC NP3 pipe should be manufactured withSulphate resistant cement and conforms to IS12330:1988 (RA2005)

ii) Aggregates

Aggregates used for the manufacture of reinforced concrete pipes shall conform to IS:383;1970. The maximum size of aggregate should not exceed one third the thickness of the pipe or 20 mm, whichever is smaller.

iii) Reinforcement

Reinforcement used for the manufacture of the reinforced concrete pipes shall be mild steel Grade I or medium tensile steel bars conforming to IS: 432 (Part1):1982(RA2004)' or hard drawn steel wire conforming to IS 432 (Part 2) or structural steel (standard quality) bars conforming to IC 2062.

iv) ConcreteorMortar

The quality and design mix requirements of concrete (concrete mix, maximum water- cement ratio, minimum cement content, etc) used for the manufacture of reinforced cementconcretepipesandcollarsshallconformtoIS:456-2000foratleastvery severe environment exposure condition and shall also be in accordance with ConcreteandAlliedworksSectionofTechnicalSpecifications.Incaseofpipescastby spinningprocess,highercementcontents,morefinesandhigherwater-cementratio may be the need of the process.

The concrete for non-pressure pipes shall have a minimum compressive strength of 35 N/mm2 at 28 days. If mortar is used, it shall have a minimum cement content of 450kg/m^3 and a compressive strength not less than 35 N/mm2 at 28 days.

Compressive strength tests shall be conducted on 15 cm cubes in accordance with the relevant requirements of IS:456-2000 and IS:516-1959.

The manufacturer shall give a certificate indicating the quantity of cement in theconcrete mix.

v) RubberRing

Rubber ringchordsusedinpipeJointsshall conformtoType 2 of IS:5382-1985.Rubbers rings shall be tested and approved before usage.

vi)The pipes shall be provided either with High Alumina Cement or Poly Urea internal lining to protect from corrosion thus ensuring long life.

DESIGN

i) General

Reinforced concrete pipes either spun or vibrated cast shall be designed such that the maximum tensile stress in the circumferential steel due to specified hydrostatic test pressure does not exceed the limit of 125 N/mm^2 in the case of mild steel rods, 140 N/mm^2 in the case of hard- drawn steel wires and high strength deformed steel bars and wires.

The barrel thickness shall be such that under the specified hydrostatic test pressure, the maximum tensile stress in concrete, when considered as effective to take stress along with the tensile reinforcement shall not exceed 1.5 N/mm^2 for non-pressure pipes. The barrel wall thickness shall be as per IS:458-2003.

Longitudinal reinforcement shall be provided to ensure rigidity and correct location of cages (grids) longitudinally and to limit the effects of transverse cracking. Minimum longitudinal reinforcement shall be as given in respective tables of IS:458.

ii) Reinforcement

Thereinforcementinthereinforcedconcretepipeshallextendthroughoutthelength ofthe pipeand shall be so designed that it may be readily placed and maintained to designedshapeandintheproperpositionwithinthepipemouldduringthemanufacturingprocess. The circumferential and longitudinal reinforcement shall be adequate to satisfy therequirements specified under (i).

Thepitchofcircumferentialreinforcementshallbenotmorethanthefollowing:

a) 200mmforpipesofnominalinternaldiameter80to150mm,
b) 150mmforpipesofnominalinternaldiameter200to350mm,and
c) 100mmforpipesofnominalinternaldiameter400mmandabove.

The pitch shall also be not less than the maximum size of aggregate plus the diameter of the reinforcement bar used.

The quantity and disposition of steel in pipes may be decided by mutual agreement between the BWSSBandthesupplier; however,itshallbeprovedbycalculationsandteststhatthequalityof the pipes conforms to all the requirements specified in the standard. In the absence of calculations and tests, the reinforcement given in the respective tables of IS:458 shall be used as minimum reinforcement.

If so required by the BWSSB, the manufacturer shall give a certificate indicating the details relating to quality, quantity and dispersion of steel in the pipes as well as the clear cover to the steel provided in the pipe.

i) EndsofPipes

Dimensions of spigot and socket for rubber ring roll on jointed pipes shall be as given in the respective tables of IS:458. Reinforcement in socket of rubber ring jointed pipes shall be as given in the respective tables of IS:458-2003.

MANUFACTURE

i) General

Themethodsofmanufactureshallbesuchthattheformanddimensionsofthefinished pipe are accurate within the limits specified in this standard. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis.

ii) Concretemixing

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour ad consistency, but in no case shall the mixing be done for less than two minutes. Water-cement ratio shall be less than 0.5.

The concrete shall be placed before setting has commenced. It should be ensured that the concrete is not dropped freely so as to cause segregation. The concrete shall be consolidated by spinning. Vibrating, spinningcombined with vibrations, or other appropriate mechanical means.

iii) ReinforcementCages

Reinforcement cages for pipes shall extend throughout the length of pipe barrel. The cages shall consist of spirals or rings and straight of hard-drawn steel wire or mild steel rod and may be circular. Circular cages and longitudinal reinforcement shall be placed symmetrically with respecttothethicknessofthe pipe wall.The spirals shallendin acomplete ringat boththeends of a pipe.

Pipes having barrel thickness **above 100 mm** shall have double reinforcement cage and the amount of steelinthe outercage shallbe 75% ofthe mass of theinner cage whilstthetotalshall conform to the requirements specified in the relevant tables of IS 458 : 2003. The total longitudinal steel per pipe shall be given in the relevant tables of the standard but thedistribution shall be such that the round shape of the cage is not disturbed.

Diagonal reinforcement may be provided in pipes for which the cages are not welded so as to help in binding the cage securely. It shall, however, be ensured that the clear cover for any reinforcement is not below the limits specified in **6.4 of IS 458.** If diagonal reinforcement is provided, it shall be considered as part of process requirement and shall not be counted against the longitudinal reinforcement and spiral reinforcement. Single reinforcement cage shall be located near the inner surface of the pipe with adequate clear cover.

iv) WaterCuring

Pipesmanufacturedincompliancewiththisstandardshallbewatercuredforaperiodofnotless than 2 weeks in case of pipes made from ordinary Portland Cement or Portland slag cement or Portland Pozzuolana cement or hydrophobic Portland cement, and not less than 1 week in caseof pipes made from rapid-hardening Portland cement or 53 grade ordinary Portland cement. Pipesmaybe water-saturated materialorbya systemof perforatedpipes, mechanical sprinklers, porous hose, or by any other approved method that will keep the pipe moist during the specified curing period. In the case of large pipe projecting partly above the water level, the projected portion shall be kept wet by any suitable means.

DIMENSIONS

Pipes

Theinternaldiameter,wallthickness,lengthofpipes,minimumreinforcementsandstrengthtest requirementsfordifferentclassesofpipesshallbeasspecifiedintherespectivetablesofIS458. Themanufacturershallinformthe **BWSSB** of theeffectivelengthof spigot andsocket thatheis able to supply.

Tolerances

Thefollowingtolerancesshallbepermitted:

Sr. No.	Dimensions	Tolerences
i)	OverallLength	:±1% ofStandardLength.
ii)	InternalDiametersofPipes	
	a) Uptoendincluding 300mm	:±3 mm
	b) Over300mmanduptoandincluding600mm	: ± 5mm

c) Over600mm :±10mm

iii) BarrelWallThickness

d) Uptoendincluding 30mm :+2mm:−1mm

e) Over300mmanduptoandincluding50mm: +3mm: −1.5mm

f) Over50mmanduptoandincluding 65mm :+4mm:−2mm

g) Over65mmanduptoandincluding 80mm :+5mm:−2.5mm

h) Over80mmanduptoandincluding 95mm :+6mm:−3mm

i) Over 95mm : +7mm:−3.5mm

Note:

In case of pipes with flexible rubber ring joints, the tolerance on thickness near the ends will have to be reduced. Near the rubber ring joints, the tolerance on thickness shall be as given in Tables 13 to 19 of IS:458.

WORKMANSHIPANDFINISH

i) Finish

Pipes shall be straight and free from cracks except that craze cracks may be permitted The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench, no opening between ends in contact shall exceed 3 mm in pipes up to 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter

The outside and inside surfaces of pipes shall be dense and hard and shall not be coated with cementwash.Theinsidesurfaceofpipeshallbesmooth.Forbetterbondtheinnersurfaceofthe collar may be finished rough.

The pipes shall be free from defects resultingfromimperfect gradingof the aggregate mixingor moulding.

Pipes shall be free fromlocal dents or bulges greater than 3.0 mmin depth and dents and bulges shall not be extending over a length in any direction greater than twice the thickness of barrel.

Pipesmayberepaired,ifnecessary,becauseofaccidentalinjuryduringmanufactureofhandling and shall be accepted if in the opinion of the BWSSB, the repairs are sound and appropriately finished and cured, and the repaired pipe conforms to the requirements of this specification.

ii) DeviationfromStraight

The deviation from straight in any pipe throughout its effective length, tested by meansof a rigidstraightedgeasdescribedinIS3597shallnotexceed,foralldiameters,3mmfor every meter run.

TESTS,SAMPLING,INSPECTIONandMARKING

All RCC S/S Non-pressure pipes are to be tested, for the numbers/scale of sampling and inspected and clearly marked as per the relevant clauses (10, 11 and 12) in IS:458-2003.

TRANSPORTANDHANDLINGOFPIPESANDOTHERMATERIALS

The specification for transport and handling of pipes shall conform to IS:783-1985 unless otherwise specified.

a) The R.C.C. pipes, base plates, machine holes frames and covers, bolts and nuts, clamps etc., shall be transported by the contractor for laying and construction work at the respective sites of work at his own cost.

b) Itis essential to transport, handle and lay the pipes, materials, etc in such a manner asnot to cause damage. In lorry/truck shipments, the pipe shall be supported in widecradles of suitably padded timbers hollowed out on the supporting surface to fit the curvature of pipe, and all chains, calves, or other equipment used for fastening the load shall be carefully padded. For smaller diameter pipes, sand or saw-dust filled bags may be used instead of hollowed out timbers. Pipes shall not be thrown down from the lorries/trucksnorshallthatbedraggedorrolledalonghardsurfaces.Slings ofcanvas orequallynonabrasivematerialsofsuitablewidthorspecialattachmentsha pedtofit the pipe ends shall be used for lifting and lowering pipes so as to eliminate the risk of damage,

c) Greatcareshallbetaken inhandlingthepipesrightfromthe firstoperation untiltheyare laid and jointed. The contractor shall be responsible for any loss or damage to the pipes and other materials.

PERMISSIONTOLAYPIPE,CONCRETE

When any portion of the excavation shall have been carried down to the necessary depth, the contractor shall obtain permission from the Engineer before commencing the laying of pipes or concrete.

LAYINGANDJOINTINGOF SEWERS

a) ThespecificationforlayingandjointingofRCCpipesshallconformgenera lly to I.S,783-1985andamendmentsthereon.

b) These specifications cover the work of laying all RCC pipe lines, under ground and above ground, including all civil works required for the same.

(a)The contractor shall manufacture the pipes for a lengthof maximum 500 m at a time.All these pipes should not be conveyed to the site at a stretch, Contractor shall carefully conveyandstackthepipesalongthesideoftheroadateverytwo machineholeslengths only.andthisshouldnotaffectthetrafficandpedestrians.

(a)LAYINGANDJOINTINGOFR.C.C.PIPES

a) Before commencing the work of pipe laying the contractor shall study the longitudinal section and other relevant details of the pipe line for the section/reach concerned. Pedestals/ cradles to be provided for shall be constructed before commencing the pipe laying work in any section, If the pipes are required to be wholly encased in concrete encasement of the pipes shall be done as per the method decided by the Engineer.

b) The contractor should check all pipes, rubber rings and other materials before hand and satisfy himself and intimate, the department if any defects are noticed or if the quality is found to be not to standard.

c) All pipes shall be carefully handled and lowered into the trench by

means of proper methods of handling. The pipes shall be handled by flat rubber belts.

d) Socketshouldfacetheoppositetothedirectionofflow.Pipeshallbenormally laid sothatspigotendentersthesocketface.Thesocketandspigotendsofthepipeshall be cleared of all extraneous matter specially of clay and grease. Rubber ring shall be clean and dry.

e) Allthepipesshallbelaidperfectlytruebothinlineandgradespecifiedinthe drawings. the rubber rings shall be kept evenly positioned on the spigot groove andwhen satisfied that the pipe and rubber ring are correctly positioned, the pipe shall be forced/pushed well right home of the full depth of the joint by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber ring shallconformto1S:53821985.Insidethejoint,thetwopipeendsshallbeinclose proximity.Properlyfittedtemporarywoodenstoppersshallbeprovidedand constantlyused toclosetheendsofallincompleted pipelines.

f) Bailingorpumpingoutofwaterfromtrenchincludingshoring,struttingand removing slush while laying, jointing and testing shall be done by the contractor.Caving,sliding,underpinning,floatationaresomeofthefeaturestobekeptinview bythecontractorandheshalltakeallrequired/necessaryspecialprecautionsduring the course of execution. The contractor shall see that water will not be allowed to accumulateinopen trenches,wherework isinanincompletestage.Precautionary works such as blank-flanging the open ends of the pipe line shall be taken up at the contractor's account and no separate payment will be made for the same. Should any sectionofthepipelinefloatduringthecontractperiod,theentirecostoflayingit againtothecorrectlineandlevelshallbetotheaccountofthecontractor.

g) Blankflanges

Blankflangesshallbeprovidedatallendsleftunattendedforthetemporaryclosure of work. At the endof a day's work, also suitable closures shall invariably be providedat the open end or ends to protect the pipe line from ingress of sub-soil water, mud, muck, debris, dust etc.

h) Wherever pipe laying work is done from two faces and/or has to be done in broken stretches due to any difficulty met with at site, to carry out final connection, the contractor should take all special precautions such as maintaining the levels, grades, alignment keeping in view the length of pipes. If any mistake or error occurs, the contractorshallrelaytheentirestretchathiscost.Anylossesordamageseitherto pipes or other material thereupon shall be at the contractor's expense and necessary recoveries shall be made.

i) Precautionsagainstfloatation

When pipeline laid underground or above ground in a long narrow cutting gets submergedinwatercollectedinthetrenchorcutting,itissubjectedtoanuplift pressuredueto buoyancyandislikely tofloat,completely orpartly empty.Inthe design of pipelines, provision is made to safeguard against floatation by providing sufficientoverburdenorbyprovidingsufficientdeadweightbymeansofanchor blocks.

In the case of the work extending into the monsoon season, however, special care and precautions are necessary during the progress of work on this account. The work of providing anchor blocks and refilling the trenches to the required level and compacting the same etc. shall always be done as soon as the pipeline has been laid.

The contractor shall see that water will not be allowed to accumulate in open trenches, where work is in an incomplete stage,

precautionary work such as blank-flanging the open ends of the pipeline and filling the pipeline with water etc. shall be taken asdirected by the Engineer. Such works shall be to the contractor's account and no separate payment will be made for the same. A two metres over burden shall be maintained at all times. Where this overburden is not available, anchor blocks have to be provided.

Protection of pipeline against floatation during the contract period shall be the responsibility of contractor. Should any section of the pipe line float due to their negligence etc, the entire cost of laying it again to the correct line and level shall be tohis account.

METHODSOFMEASUREMENT

1. For manufacture, supply and delivery of pipes, measurement shall be taken for actual number of pipes multiplied by the standard length.
2. MachineholeshallbemeasuredpermachineholesasprovidedintheBillofQuantities.
3. Laying and jointing of pipes and specials and valves will be measured in linear meters along the centre line of the pipes actually laid, jointed and tested and will be limited to the number of pipes x standard length + part length of pipe if any. The rate shall include the cost of rubber ring.
4. Anti floatation blocks, pedestals and any other concrete structures shall be measured volumetric ally (cum.).

SPECIFICATIONFORSULPHATERESISTANCECEMENTPIPESAND HIGH ALUMINA CEMENT LINED PIPES

GENERAL

Pipes up to and including 900mm dia should be manufactured with Sulphate Resistant (SR) Cement confirming to IS: 12330-1988.

Pipes up to and including 900mm dia shall be lined with 12mm thick high alumina cement with SR cement. The main purpose of using High Alumina Cement for lining is to protect the pipe against sulphate attacks when it is used in sewer lines.

Thenormalproportionofthemixshallbeasfollows:

1. HighAluminacementonepart-asperIS:6452.
2. GranitedustpassingthroughI.S.sieve150micron-onepart
3. FineaggregatepassingthroughI.S.sieve1.18mmasperI.S.383
4. Water cement ratio of the lining mix shall not be more than 0.35 and shall be sufficientto ensure maximum density.

PROCESSOFMANUFACTURE

Thepipes shall be made byspinningprocess.The centrifugal force generated byspinningaction will force the concrete against the mould, removing excess resulting in a dense concrete.

ThemixforHighAluminacementliningshallbemixedinsmallseparationmixer.

All the ingredients shall be weighed. As soon as the spinning of pipe is completed, the cement mortar shall be fedinto the rotating mould uniformlyand the pipe shall be spun until the cement mortar is set.

PRECAUTIONTOBETAKENFORHIGHALUMINALINING

1. It is not desirable to mix and do the lining in high constant temperature (temperatures more than 40 C). Hence, it is advisable to manufacture the pipe when temperature is lower than 40C.

2. Streamcuringshouldnotbeusedforcuringpipes.

3. The high alumina lining shall be kept moist and cool for the first 24 hours.The curing of lining shall be started after 3 to 4 hours after operation.

4. Thewatercementratiooftheliningshallnotbemorethan0.35

CHAPTER-11

PIPEJACKING

Pipe Jacking

General

(a) Where required, sections of the pipeline shall be laid by pipe jacking. The Contractor shall engage a professional having experience in Trenchless Technology to design and be responsible for the supervision of the construction of the jacking pits.

(b) Plans and details of the equipment, materials and the method of construction to perform and complete the work shall be submitted by the Contractor and must be approved by the Engineer in charge before commencing these operations. Approval of the Engineer in charge shall not relieve the Contractor of his sole responsibility for the efficacy, reliability, soundness of the method employed in completing the work in a satisfactory manner.

(c) It shall be the responsibility of the Contractor to satisfy himself as to the soil conditions along the pipe jacking route and if he judges it to be necessary, he shall carry out soil investigations at his own cost.

(d) It shall be the responsibility of the Contractor to maintain stable soil conditions at the jacking face to prevent loss of ground above the jacking operation and movement of the surrounding earth. The methods of maintaining face stability and preventing ground movementandsubsidenceshallbebymeansofcompressedairorotherplen ummethods where fluid slurry or earth pressure is applied to the tunnel face. Alternatively, unstable groundaheadofthejackingfacemaybestabilizedbytheinjectionofsuitabl echemicals. Methods which require dewatering of the ground will not be accepted, nor will methods which may lead to significant ground loss. The Contractor's proposal must be submitted to the Engineers incharge for his approval.

(e) It is the Contractor's responsibility in ensuring that the pipe jacking machines are installed and removed at the designated launching and receiving pits. In the event that any additional pits need to be installed to either remove any obstruction at the face ofthe jacking machine, failure of jacking of machine or for any other reason, the Contractor shall bear all cost incurredin constructingthejackingpits andreinstatingthe ground to the original condition, subject to the approval of the relevant authority eg BMP, BDA, Police and the satisfaction of the Engineers incharge.

(f) Movement or settlement of structures, utilities and pavement shall be monitored by the Contractor during the jacking operation and reported to the Engineers incharge. If movement or settlement occurs which, in the opinion of the Engineer in charge may cause damage, the Contractor shall take immediate action to prevent further movement, settlement or damage. The Contractor shall repair at his own cost any damage and restore structures or pavements to the satisfaction of the Engineer in charge. Any damage to utilities duringthe executionshall be rectified byContractor onhisown cost.

(g) The Contractor shall be responsiblefor inspectingthelocation and familiarizing himself withtheconditionsunderwhichtheworkwillbeperformedandwithallnece ssarydetails as to the orderly execution of the work. The omission of any details shall not relieve the Contractoroffullresponsibilityforthesatisfactoryinstallationoftheworki nitsentirety.
NomonetaryorotherclaimsmadebytheContractoronthegroundsofwant ofknowledge will be entertained by the Board.

(h) (g) The Contractor shall co-operate and shall have proper understanding about other contract packages of S4 components

(i) The Contractor shall have to work with a mutually agreeable Bench

Mark under other contract packages of S4 components.

(j) The Contractor shall have to liaison with other utility agency like BMP, BDA, Police, KPTCL, BSNL and other private users to get proper permissions for the required work.

(k) The Contractor shall be paid as per BOQ i.e. per running meter basis. This includes the costofalltheactivities,material,includingtheMScasingpipeitems,investigation

works, precautionary measures during execution including change in the approved methodology etc. There is no separate or addition payment.

PipesforJacking

(a)The pipes for jacking operation shall be MS pipe of as specified in the Bill of Quantities or as directed by the Engineer in charge. The carrier pipe of RCC NP3 pipe will be laid inside the MS pipe with proper joining & slopes as per specification & drawings.

(b) The supply of pipes shall be in accordance with the Specifications.

PrecastReinforcedConcretePipes(CarrierPipe)

(a)The precast reinforced concrete pipes shall be manufactured by a centrifugal or other equivalent process to be approved by the Engineer in charge. Design, manufacture and factory testing of the pipes and specials shall be to as per IS 458 (Latest Revision) andBS 5911-I (Latest Revision). The clear cover of concrete over steel reinforcement shall not be less than 50 mm.

(b) All pipes except for those less than 900 mm diameter shall be manufactured with twosets of grout holes. Each set shall consist of three grout holes spaced at 120on centres circumferentially located at the quarter points from either end of the pipe. Two of these grout holes shall be at the soffit of the pipe.

(c)Thestrengthofthepipesshallbetestedbythethreeedgebearingtest.When subjectedto the design load in such a test, the maximum crack width developed on the pipe shall not exceed 0.25 mm. All such tests shall be carried out at the expense of the contractor.

(d) The contractor shall submit full details of his proposals for the pipes, giving detailed drawings showing sizes, reinforcement and type of joints, calculations, together with the name of the proposed manufacturer, the place of manufacture, and the manufacturing processes tothe Engineers incharge for approval.All workmanshipand materialsusedin themanufactureshallbesubjecttotheapprovaloftheEngineersinchargew hoshallfrom timetotimebepermittedtoinspectmaterialsatsourceandthemanufacturi ngprocessesin the factory.

(e)The pipes shall be sufficiently matured before they are used in the construction of the works. They shall be handled with extreme care to prevent the edges of the pipes from chipping. Repaired pipes shall not be allowed for use in the contract. The Engineers incharge may reject any pipes he considers not suitable for the works and these rejected pipes shall be removed from the site immediately. After factory testing and before despatch,everypipeandspecialshallbemarkedinaccordancewiththestan dardused.In addition, each pipe shall be marked with a number corresponding with the order of manufacture. Test certificates from the manufacturers or other relevant authorityshall be submitted to the Engineers incharge.

(e) Where steel collars are used for pipe joints, it shall be made of weldable structural steel Grade 430with minimumyieldstrengthof275 N/mm^2 asspecifiedinTable2ofBS3601.The collars shall be of dimension and thickness to be approved by the Engineers incharge. Beforefittedtothepipes,thecollarsshallbecoatedwithapprovedanti-abrasiveandanti-corrosivematerialssuchaspolymorphicresinorequivalent.Jointsealsshall be

manufacturedfromEPDM,complyingwiththerequirementofBS7874(Latest Revision).

(f) Where steel shield is utilised during the jacking operation, this steel shield shall be bolted to or by other approved means joined to the first piece of pipe which is being jacked.

(g) All the loading conditions during installation state and operation state to be submitted for the design review. Contractor shall submit the design of pipes for Engineers approval. Pipe shall be designed in accordance with the following standards (Latest Revisions):

IS:456	PlainandReinforcedConcrete-CodeofPractice
IS:458	Precast ConcretePipes (withandwithoutReinforcement)– Specification
IS:3370	Codeofpracticeforconcretestructuresforthestorageofliquids: (Part-
BS:5911-I	Concretepipesandancillaryconcretepipes,specification for unreinforcedandreinforcedpipes(includingjackingpipes)and fittingwithflexiblejoints
IS:2062	Steelforgeneralstructuralpurposes
IS: 10748	Hot-rolledsteelstripsforweldedtubesand pipes

JackingRingandFrame

(a) The Contractor shall be required to use ajackingring. Thejackingringmaybe either of steel or concrete construction and shall be used at all times when a pipe is being jacked. This jacking ring will allow the jacking pressure to be distributed evenly around thewall of the pipe.

(b) The Contractor shall also be required to use a jacking frame during all operations. The jacking frame shall be designed to distribute the stresses from the jacks evenly to the jacking ring.

JackingOperations

(a) The Contractor shall be fully responsible for the materials, equipment and facilities required in conjunction with jacking the concrete pipe.

(b) Before starting work, the Contractor shall submit to the Engineers incharge forapproval, a detailed schedule of the entire jacking operation. Approval of such schedule shall not relieve the Contractor of his responsibility to provide a fully satisfactory installation. The Contractor shall be required to include with his submission evidence that he has successfully completed a jacking installation using procedures similar to those proposed.

(c) Where chemical stabilization of soil is used, a chemical grout shall be pressure injected into the soil over and ahead of the pipe jacking to stabilise the soil. The chemical grout used shall have a demonstrated

history of success for stabilizing soils similar to that through which the pipe is to be jacked.

(d) Where a mechanical shield is used, the Contractor must provide proof that the particular model of shield has been used successfully in soils similar to that on the site. The crew for the operation of the shield must be specialist, with experience in the use of that particular type of machine.

(e) After the jacking operations has begun, the Contractor may have to work continuously (24 hours per day) if required and directed by the Engineers incharge until the complete length of jacked pipe is installed.

(d) The pipes shall be jacked into place, true to line and level. The maximum tolerance allowable inthe displacement of the centreline ofthe laid pipefromthe design centreline is 50 mm in the horizontal plane and 15 mm in the vertical plane but there shall be no back fall at any point. Any pipe which is not laid in its correct position must be removed and re laid or adjusted to obtain its correct position.

(e)For precast reinforced concrete pipes, there shall be provision to prevent the relative movement between pipes at the joints by the use of steel gaiters or other approved methods during jacking operation. A packing piece of compressible material shall be provided at each joint and shall be securely held before the pipes are lowered into the thrust pit. Details of proposals shall be submitted to the Engineers incharge for approval.

(f) The Contractor shall be required to furnish and install and remove to the extent required, thrust blocks or whatever provisions that may be required for backing up the jacks employed in driving the pipe forward. The jacking pit shall also be equipped with steel rails or beams embedded in concrete. These rails or beams will be used for placementand alignment of each pipe during the jacking operation.

(g) The Contractor shall be fully responsible for the design and construction of the jacking and receiving pits, thrusting wall, installation of jacking equipment, sheeting, bracingetc. and for the efficient execution of the jacking operation. Full details of the proposals, including plant, shield machine, equipment, operating procedures, jacking pit and intermediate jacking stations etc, shall be submitted to the Engineers incharge and shall be fully satisfactory to him before construction work begins. However, review of the plans shall not relieve the Contractor from his responsibility to provide a safe and satisfactory jacking pit.

(h) TheContractor shallberequired to monitorcloselytheprogressofthejackingoperation. Daily site records of thrusting pressures and the line and level measurements shall be properly maintained and shall be available to the Engineers incharge at all times.

(i) It is the responsibility of the Contractor to ensure that the complete "tunnels" are watertight. If leakage occurs before completion or during the maintenance period, the Contractor shall carry out any remedial work that may be necessary to make the Works watertightallathisownexpense.Contractorshallcarryoutthehydraulictes tingasperIS 458 (Latest Revision).

(j) Contractor shallfollowall safe workingpractices accordingto IS-4756 (Latest Revision) and BS-6164 (Latest Revision).

(a)The Contractor shall be fully responsible for preventing the occurrence of voids outside the pipe and if they occur he shall fill them with cement grout.

(b) Immediately following the jacking operation, the Contractor shall pressure grout the jacked section to fill all voids existing outside the pipe.

(c) (c)Systems ofstandard pipe, fittings, hose,andspecial groutingoutletsembedded inthe pipewallsshallbeprovided bytheContractor. Careshall betaken toensurethatallparts of the system are maintained free from dirt. Grout composed of cement, sand and other approved compound and water shall be forced under pressure into the grouting connections at the invert and shall proceed until grout begins to flow from upper connections. Connections shall then be made to these holes and the operation continued to completion.

(d) Apparatus for mixing and placing grout shall be of a type approved by the Engineers incharge. It shall be capable of mixing effectively and stirring the grout and then forcing it into the grout connections in a continuous uninterrupted flow.

(e) After grouting is completed, pressure shall be maintained by means of stop cocks, or other suitable devices until the grout has set sufficiently. After the grout is set, grout holesshall be completelyfilled with dense concreteand finished neatlywithout evidence of voids or projections.

Methodsof Construction-Break-OutsfromShaftsandTunnels

(a)For the junctions of tunnels and shafts the Contractor shall submit, for the Engineer In charge'sagreement amethodstatement describingthedetailsof thework,withdrawings and calculations.

(b) Tunnel and shaft linings shall not be broken out until all necessary temporary works, including ground treatment, where appropriate, have been completed to ensure the structural and geotechnical stability of the works.

(c)Temporary supports shall not be removed until so agreed by the Engineer in charge and the work for which they are required has been completed and the structure is capable of carrying the imposed loads. Once junction work is commenced it shall be completed as expeditiously as practicable.

(d) The break-out shall be of sufficient dimensions to accommodate the permanent structure to be built. Working space shall be kept to the minimum dimensions practicable.

(f) The break-up for a tunnel shall enable the construction of a stable initial length of an adequate tunnel lining, built within the specified construction tolerances.

(g) Ground improvement or other acceptable means shall be provided at shaft break-outsand break-ins as required to prevent instability of the ground as the sewer excavation exits or enters a shaft and elsewhere as required.

(h) The Contractor is deemed to have included in their price the

cost of the interface with other contract including any ground improvement required to allow the access to theshaft or for the pipe jacking machine to be recovered as part of the works. The contract interface works are deemed to include shaft break-in or shaft breakout.

LimitsofSurfaceSettlement

The method of jacking adopted by the Contractor shall be such that the initial surface settlement measured directly above the front face of the shield during the jacking operations do not exceed 25mmandthemaximumsurfacesettlementafterthetailvoidsaregroutedshallnot exceed50
mm. Subsequently, the ground shall be reinstated to the original level not with standing, for the sections of pipeline near to sensitive structures, crossing under all roads along the route of the pipeline and paved area, the Contractor shall be required to incorporate in his jacking method measures to arrest the expected settlements so as to safeguard the integrity of the structures and road surfaces at all times. The Contractor shall ensure that the operational functions of these sensitive structures and traffic flows along all roads are not affected in any way by his work.

Shafts

Shafts-General

a) The working shaft shall be used for the construction of a machine holes/chamber. The Contractor to construct the Jacking & Receiving pit as a permanent structural in RCC which would be served as a machine holes during operation. The Jacking pit/Receiving pit would be converted into the machine hole with necessary modifications including constructionofthetopslab, machineholescoverframe,pipebenching,CIrungsetc.The Contractorto preparethe design & drawings asperthe permanent structure requirements & shall be got it approved from the engineer.

(b) TheContractorshallsubmitforapprovaltotheEngineersincharge dimensioned drawingsandcalculationsofthetimberingortrenchsheetingdetailsforthe working shafts. Each working shaft shall have a separate ladder bay for access, which shall be isolated from the part of the shaft used for hoisting materials.

(c)Prior to excavation, the shaft area shall be thoroughly checked for existing utilities and the appropriate measures taken in agreement with the Engineers incharge.

Shafts-Safety

(a)Shaftsshallbeprovidedwithguardrailsorringsatleast1.2mabovethe surrounding ground level.

(b) Oncesunktofinallevel,theshaftsforregularpersonnelaccessshallb eequippedwith laddersandlandingsatintervalsnotexceeding6m.Protectionshallbesopr ovided

thatneitherladders,supportingstructures,norpersonsusingthemare subjecttorisk

of accident, fromthe passage of skips, spoil or materials. All ladders are to be secured at the top and bottom.

(c)Should heavy plant and heavy loads have to be located in close proximity to any shaft, the Contractor shall take into account the effects of these loads as well as any ground loads when designing the shaft.

(d) TheContractorshallguardagainstdistortionofshaftliningduringco

nstructionandthe possibility of shaft settlement or uplift at an intermediate stage of construction.

TemporaryShafts

(a) Full details of temporary shafts required by the Contractor's shafts working methodsshall be submitted to the Engineers incharge for his agreement. Such shafts shall be adequately sized for all operations required for the execution of the works.

(b) Backfillfortemporaryworkingshaftsshallcomprisematerialagreedbytheengineers in charge.

(c) Where the Contractor wishes to recover temporary shaft linings the structure shall be removed in safe stages as backfilling proceeds, taking care to maintain the safety and structural integrity of the remaining lining. No part of temporary works shall be left inthe ground within 2 m of the designed final surface level.

Shafts-Construction

(a) Shaft sinking shall be carried out by a method suitable for all the particularcircumstances of the site including ground parameters, groundwater, depth and final purpose.

(b) Where work is done by underpinning, only that ground which may be safely excavated for the installation of one ring or one unit of support shall be carried out. Until thatdepth is properly secured by permanent or temporary shaft lining, no further excavation shall take place. In the case of pre-formed rings securing shall include grouting.

(c) Where work is done by a caisson operation, a cutting edge shall be fitted to the leading ring. The cutting edge shall be maintained at an even level all round during shaft sinking. Jacking arrangements or kentledge shall be adequate for the work. The Contractor's arrangements shall ensure the stability of any kentledge. A lubrication space shall be maintained around the full shaft periphery during sinking.

(d) Concrete walls installed by slurry trench or secant piling techniques shall comply with best practice.TheContractor'sproposalsshallbesubmittedtotheS.O.forhisagreement.

(e) Where low pressure compressed air is used to assist shaft construction, air decks and locks shall be designed by the Contractor to give adequate margins of safety against the airpressurestobeusedintheshaft.TheContractor'sproposalsshallbesubmittedtothe Engineers in charge for his agreement.

(f) Full details of temporary works required by the Contractor's method of working for the construction of tunnel or pipe jack eyes in the shaft lining, shall be submitted to the Engineers in charge for his agreement.

(i) Shaft bases shall be concreted. The Contractor shall submit his proposals for the shaft base structure taking account of ground and groundwater forces and sealing the shaft against water entry.

MildSteelPipeWork(JackingPipe)

Spiral welded pipes manufactured from HR coils conforming to

IS 10748 Grade 3

steel.PlateweldedpipesmanufacturedfromplatesconformingtoIS2062GradeB steel.

I. ManufactureofPipes

- **General**

Steelpipeshallbeeitherplateweldedorspiralweldedpipe.

The pipes shall be truly cylindrical, and straight in axis. The ends shall be accurately cut and prepared for field welding. The external circumference of the pipe pieces which are to be fixed adjacenttoflangeadapterwithfixedouterdiametershallnotdeviatefromtheoreti calonebymore than 2 mm.

Any pipe or part thereof which develops injurious defects in the opinion of Engineer shall be rejected and shall be replaced by new pipe at Contractor's expense.

II. PlateWeldedPipes

All pipes and specials shall be manufactured out of mild steel plates conforming to IS 2062 Grade B steel. The procedure of cutting plates to size, rolling of plates, post bending, tack welding, internal and external welding, facing should be such that it results in pipes of required diameter and thickness conforming to IS 3589, or equivalent or better international standards.

III. SpiralWeldedPipes

All spiral welded pipes shall be manufactured as per IS 5504. The requirements for weldable hot-rolled carbon steel strip in coils should conform to IS 10748 Grade 3. The process of manufacture should be such that it results in pipes conforming to IS 3589/IS 5504 or equivalent international standards.

Demonstration

Contractor shall make necessary arrangements to demonstrate at the pipe manufacturing mill individual items of work before commencement of works and during the works at intervals specified and as directed by the Engineer. No payment shall be made in this regard.

Theworksunderdemonstrationshallinclude

(i) Manufactureofpipeandspecials
(ii) Chemicalandmechanicaltestingofpipesandspecials
(iii) Machineandmanualweldingtoqualify'WeldingProcedures'
(iv) Externalcoating
(v) Cementmortarlining
(vi) Hydraulictestingaftercementmortarliningat12barpressure

Tolerances

TolerancesforpipesshallbeinaccordancewithIS:3589exceptforthefo

llowing. Negative tolerance on pipe wall thickness is not

permissible.

Thepermissibletolerancesforspecialsfordiameter,armlengthandangulardeviati onshallbe in

accordancewithIS7322/BS534

Welding

Upon receipt of the order and prior to the start of works, the Contractor shall submit to the Engineer for his approval the 'Welding Procedure Method Statement' he intends to use for the field welding.

All components of pipe shell; either straight or bent etc. shall be welded by use of automatic arc welding machine by submerged arc process with alternating current. The strength of the joint shall be at least equal to that of the parent material. Manual welding shall be adopted only when machine welding is not possible.

The Contractor shall use electrodes of approved make and size, the size depending on the thickness of plate and the type of joint. Standard current and arc voltage required for themachine shall be used with necessary modifications as may be found necessary after experimental welding. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer for qualifying the Welding Procedure Method Statement. Only approved welding procedures shall be used throughout the work and if any modifications are to be made, the written permission of the Engineer shall be obtained.

AlltheshopandfieldweldingshallconformtoIS4353,IS9595andIS816.

Alllongitudinal/spiralandcircumferentialjointsshallbeSingle-VorDouble-Vbuttjointswith or without backing plates. After completing the welding joints of pipes or plates from one side, and before the welding on the other side, the joints shall be back chipped/ gouged and ground to remove irregular penetration till the even surface is exposed. Gouging shall be resorted to when the plate thickness is above 6 mm.

All circumferential welds involving plates of unequal thickness shall be so kept that the inside surface of plates match to provide stream lined joints without alteration in the internal diameter.

The welding shall be of the best workmanship free from weld defects. In order to maintain agood standard in welding, welders shall be tested by the Contractor before they are entrustedwith the job. Qualification standard for welding procedures, welders and welding operators shall conform to IS: 7307 and IS: 7310 (latest). Only those who pass the test shall be allowed to work on the job. Periodical tests as regards their competence shall also be taken at suitable intervals and those found incompetent shall be removed from the job. If an incompetent welder hasalready welded some pipes, all welding done by him previously shall be fully checked by X-ray in addition to the regular X-ray inspections. The defects if any shall be rectified to thesatisfaction of the Engineer. All such check tests and rectification of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory and qualified. Site welds shall be done by welders qualified for the various welding positions as per applicable IS codes and standards.

A record shall be maintained showing the names of welders and operators who have worked in each individual joint. Manual arc welding shall preferably be carried out by a pair of welders so that, by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or a pair shall be as far as possible, completed by them in all respects, including sealing run. No helper or other unauthorised person

shall be permitted to do any welding whatsoever.

The weldment should not become brittle or sensitive to blows and there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment shall match with the base metal properties including original ductility. The weld should in no point be lessthanthenominalthicknessofplate.AslightreinforcementasperIScodesshall be

maintained on all weld joints. Final welding of closure gaps should be carried out within a temperature range of average air temperature8° C.

- **Radiographofweldedjoints**

Soon after welding, each longitudinal / spiral and circumferential welded length, the minimum length ofthe weldatrandomfor each pipeshallberadiographedto detect weldingdefects, as per the requirements of IS 4853 and as directed by Engineer. This sampling will be at random to ensure 100% coverage of junctions of longitudinal / spiral and circumferential joints. If theresults of such radiography fail to conform to the requirements, the Contractor shall carry out at his expense 100 % radiography test for the pertinent pipe as directed and fully satisfying the Engineer.

Thepercentagebreakdownofradiographyisasfollows:

PipesandSpecialsmanufacturedatMill/

Factory-10% Field joints welded at site

- 5%

The weld ripples or weld surface irregularities and slag etc., on both inside and outside shall be removed by any suitable mechanical process to a degree such that resulting radiographic contact due to any remaining irregularities cannot mark or be confused with that of objectionable defect. The radiograph shall be made in strict accordance with the latest requirements and as per the latest and most efficient technique either with X-ray or gamma ray equipment.

The radiographs are to be marked in such a way that the corresponding portion of the welded seam and the welder can be readily identified. All radiographs will be reviewed by the Engineer to identify the defects and determine those which requires rectification. Defects that are not acceptable shall be removed by chipping, grinding or flame gouging to sound metal and the resulting cavities shall be welded. After rectification, the joint is to be radiographed again to prove the quality of the repair. The radiographs will be judged as acceptable or unacceptable by the Engineer based on the latest standards prescribed by relevant Indian Standard specification.

All X-rays shall be taken with equipment and by personnel of the Contractor. Films shall be developed within 24 hoursof exposure and bereadilyaccessible at alltimes for inspection bythe Engineer. The Contractor shall provide for the use of the Engineer suitable X-ray viewing equipment. X-ray films shall be properly maintained by the Contractor. A complete set of radiographsandrecordsasdescribedinIS:2595, foreachjobshallberetainedbytheContractor. All films shall be identified by the number and chart prepared indicating location of any work associated with the pipe erection and such inspection shall be performed by the Radiographer at the discretion of the Engineer.

HydraulicPressureTestatPipeManufacturingMill

A hydraulic test shall be carried out at the mill for each pipe length fabricated. All pipes and specials shall be subjected to hydraulictest after fabrication, but beforeapplication of protective coatings and linings.

Prior to testing, the pipe shall be inspected thoroughly and all the apparent

defects in welding such as slag, porosity etc. shall be repaired by gouging and re-welding.

Each pipe shall be filled with water slowly and the pressure increased uniformly until the required test pressure is reached. The test pressure shall be as follows:

MSpipesandfittings–12bars.

The pipe to be tested shall be given a serial number which shall be painted with details such as pipe number, shell thickness, diameter, length etc. It shall be entered in the register to be maintained by the Contractor. The register shall be maintained in suitable format giving the following information for each shell tested:

a) SerialNo.
b) PipeNo.
c) Dateoftest
d) Specification,diameterandwallthickness
e) Weightofpipeshelltested
f) Maximumtestpressure
g) Detailsoftest performance
h) NameofEngineer'srepresentativewitnes

singtests A copy of these details shall be furnished

to the Engineer

For indicating the pressure inside the pipe an accurate pressure gauge of approved make duly tested and calibrated for the accuracy of readings shall be mounted on one of theclosures which close the pipe ends.

The pressures shall be applied gradually by approved means and shall be maintained for at least 10 minutes or till the inspection of all welded joints is done during which time the pipe shall be hammered throughout its length with sharp blows, by means of a 1 kg. hand hammer.

The pipe shall withstand the test without showing any sign of weakness, leakage, oozing or sweating. If any leak or sweating is observed in the welded joints, the same shall be repaired by gouging and re-welding done after dewatering the pipe. The repaired pipe shall be re-tested to conform to the specified pressure.

If any leak or sweating is observed in pipe shell the pipe under test shall be rejected. The Engineer shall be supplied with two copies of the results of all the tests carried out.

No pipe shall be transported from the mill to the site and laid unless they have beenhydraulically tested.

TestsandInspection

TheContractorshouldsubmitresultsofinspectionandtestingcoveringthefollowinginasuitable proforma, at the time of delivery of pipes in accordance with IS 3589/IS 5504. In case of discrepancy between the requirements of the above standards the more stringent conditions shall apply. Each pipe shall be subjected to mechanical and hydraulic tests as per IS 3589 and the corresponding test certificates shall be furnished along with. The test specimen shall exhibit mechanical andchemical propertiesnotlower thanthose specifiedfor IS2062 Grade B/IS10748 Grade 3 steel. The tests should also include determination of yield strength, tensile strength, elongation and bend tests. Tensile tests shall be carried out in accordance with IS 1894 on a test specimen provided fromeach lot of 100 lengths of pipe. Guided bend tests shall be carried out in accordance with IS 3589/IS 3600. One bend test shall be carried out from each lot of 50 lengths. The tests shall comply with the requirements specified in IS 3589/IS 3600.

TheContractorshallsubmitthefollowing:

- pipemanufacturingprocess
- gradeofpipe

- chemicalcomposition–productanalysis

- jointers

- tensiletestreport

- flatteningtestreport
- weldtest reports

- hydrostatictestreport

- bendtestreport

- radiographyreport

- weldtestreport

The Contractor should notify the Engineer, in advance of the procurement of materials and fabrication in order that the Employer may arrange for mill and shop inspection (including third partyinspection).Thecostoftestsincludingthirdpartyinspectionshallbeat Contractor'sexpense.
TheEngineerinhisopinionmayrejectanyorallmaterialsorworkthatdoesnotmeet withanyof the requirements of this specification. The Contractor shall rectify or replace such rejected material/performedworkat hisowncost tothesatisfactionof theEngineer.TheEngineer hasthe righttohavethe materialtestedindependentlytoconfirmthequalityoftheworks.

The Contractor shall supply free of cost required specimen of materials for testing by the Engineerat anytime duringthe progressof workandshall bearthe cost ofsuchtests orreteststo the satisfaction of Engineer.

No separate payment will be made for any of the inspection and tests mentioned above and the rates for the items concerned shall be deemed to have been included in Contractor's item rates.

MechanicalTests

The test plates shall be subjected to all mechanical tests as per the approved Method Statement,or asotherwisereasonablydirected bytheEngineer.Testsshallbecarriedoutinaccordance with relevant standards. The tests shall include determination of yield strength, tensile strength, elongation and bend tests. Tensile tests shall be carried out in accordance with IS 1894. One test plate shall be provided for from each lot of 100 lengths

If a test specimen shows defective machining or develops flaws not associated with welding, it may be discarded and another specimen submitted. The welded joint shall exhibit mechanicaland chemical properties not lower than those specified for IS 2062 Grade B.

GuidedBendtestshallbeinaccordance withIS3589/IS3600.One bendtestshall becarriedout from each lot of 50 lengths. The test shall comply with the requirements specified in IS 3589/IS 3600.

The field welded joints shall be tested in accordance with the procedure laid down in IS 3600. One test plate shall be taken for every 10 joints and shall be subjected to mechanical and chemical tests as specified above.

Re-tests

If the results of tests of any lot do not conform to the requirements specified, retests of two additional specimens from the same lot shall be made, each of which shall conform to the requiredspecifications.Incaseofafailureofoneorboth,gougingandrepairingsha llbecarried

out to the particular lot of joints from which the samples have been taken as directed by the Engineer before the lot can be accepted. The rectification process also shall have adequate test plates and they shall be tested for compliance with the IS codes/standards.

In case both the samples yield satisfactory results in the re-test described above, gouging and repairing will be required to be carried out on the joint which has failed in the initial test only.

All charges in connection with re-testing of the welded samples including machining, testing etc. shall be borne by the Contractor.

Marking

All pipes and specials shall be carefully marked for identification in the field. The marking shall be on the side which will be the inside of the pipe after bending. The marking operation shall be conducted with full size rulers and templates with suitable paints.

Thefollowinginformationshallbeclearlymentionedoneachpipeandspecial.

Manufacturer'snamewithhisregisteredtra

demark Pipe / special with its serial

number

Processofmanufacturerandtypeofs

teel Outside diameter (mm)

Pipewallthickness(mm)

Lengthofpipe/

angleofbend(indegrees) Date of

manufacture of pipe and special

Test pressure

After the hydraulic tests on the specials the direction of flow shall be

stamped in a prominentmanner. **Transportation, Handling, Stacking**

and Inspection

- **General**

All pipes and specials manufactured at the mill shall be transported to the site of laying after cleaning them internally, etc. Vehicles on which pipes are transported shall have a body of such lengththat thepipesdonotoverhang.Pipesshouldbesecureduringtransit.Toensurethat laying of pipes is not held up at any time, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug plates, machine holes covers and short length of smaller diameter pipelines at site in his field stores in consultation with the Engineer. Whenever possible, the Contractor shall arrange one full month's requirement of pipes, specials, etc. stacked suitably along the alignment. All gaskets, nuts and bolts flange adaptors and other similar items shall be stored in dry conditions, raised off the ground in

sheds or covered areas. Until required for incorporation each rubber ring or gasket shall be stored away from windows, electricalequipment and other materials like oil and chemicals and also from heat and cold. Where items require special storage requirements, the method of storage shall be to the approval of Engineer and in accordance with manufacturer’s requirements. Storage areas shall be set out to facilitate unloading, loading and checking of materials. End covers and other protection shall not be removed until incorporation of the pipes or fittings into the Works. The Contractor shall provide

2 (two) sets of accurate ‘Go” and ‘No Go’ ring gauges to measure the diameter of pipes, specials and fitting for the use of the Engineer at no extra cost.

- **TransportationandHandling**

The pipes and specials shall be handled in such a manner as not to distort their circularity or cause damage to their surface. Contractor shall provide temporary props in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of laying. The props shall be retained until the pipes are laid. Details of proposed propping (strutting) system shall be submitted to Engineer for approval and if required by the Engineer, the method of propping (strutting) shall be demonstrated and tested at site. Valves shall not be lifted by the spindle

Pipe handling equipment shall be maintained in good condition and any equipment which in the opinion of the Engineer may cause damage to the pipes shall be discarded. Under no circumstances shall pipes be dropped, be allowed to strike one another, be rolled freely or dragged along the ground. No defective/damaged pipe shall be used in the works without rectification to the satisfaction of the Engineer. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer.

- **StackingandInspection**

The Contractor shall keep a responsible representative to take delivery of pipes, specials and appurtenances, etc., transported from the pipe manufacturing factory or a stock yard. Pipes and appurtenances should be handled, stored and stacked in a suitable manner as directed by Engineer. Padding shall be provided between coated pipes and timber skids to avoid damage to the coating. Gaps must be left between stacked pipes to permit access from one side to theother. The pipes, specials and appurtenances received at site shall be inspected and defects such as protrusions, grooves, dents, notches, damage to the protected coating, etc., shall be pointed out to the Engineer at site and in acknowledgement challans. Such defects shall be rectified or repaired by the Contractor at his expense, to the satisfaction of the Engineer. It will be the responsibility of the Contractor to protect the pipes, specials and other items stacked along the alignment against any possible damages or theft.

ExternalCoating

Unlessotherwisespecifiedorstatedonthedrawingsthepipelineofdiametermore than1000mm to be laid underground and the exposed pipeline supported on saddles shall be cement mortar coated

- **ExternalGuniting**

CementmortarcoatingshallbeinaccordancewithIS1916.

(i) CementshallbePortlandCementinaccordancewithIS8112
(ii) Thecement contentshallbe600kg/m^3andwater:cement ratiobymassshallnot exceed 0.3:1
(iii) Alengthof15cmateachendofthepipeshallbeleftungunitedtofacilitatesite welding. The end faces shall be vertical.

- **MixProportion**

Cement mortar shall consist of 3 parts sand to 1 part cement by volume. The water in themixture shall be carefully controlled so as to attain the required strength and so that the mortar will not run, sag or segregate.

- **Thicknessofcoating**

The minimumthickness of the coating shall be 25 mm with a positive tolerance of 3 mmand no negative tolerance. Checking of the coating thickness shall be by non-destructive means such as ultrasonic thickness gauge.

- **SurfacePreparation**

The surface of all pipes to be coated with cement mortar shall be thoroughly cleaned by hand or by sand steel grit blasting if necessary. After cleaningthe external surface of pipe shall be given a coat of cement wash.

All oil and greases on the surface of the metal shall be removed thoroughly by flushing and wipingusingsuitable solvents and clean rags. The useof dirtyoroilyrags will not bepermitted. All other foreign materials shall be moved by buffing or by scrapping and wire brushing. After cleaning, the pipeshall beprotected and maintained free of all oil, grease and dirtthat might fall upon from whatever source until the pipe has received its cement mortar coating.

If blasting is necessary, all metal surfaces shall be thoroughly blasted to bright metal. Blasted surface which acquire a coat of rust shall be cleaned/reblasted as directed by the Engineer

- **Reinforcement**

Reinforcement for the coating shall comprise of 50 x 50 x 3 mm wire mesh conforming to IS 1566 and 8 mm dia. bar to IS 1786. The mesh sheets shall overlap each other by a minimum of 100 mm and be tied with mild steel wire at 200 mm intervals. The reinforcement shall be held off the pipe wall by a series of 10 numbers equally spaced 8 mm dia reinforcement bars which shall run the full length of the coating. Clear cover to the reinforcement shall be in accordance with IS 1916.

- **Application**

The pressure in the lower chamber of ‘Cement Gun’ shall be sufficient to produce a nozzle velocityof 115 to 150 m/sec when a tip with 19 mmopeningis used.The compressor used shall be of an adequate capacity to maintain a pressure of at least 2.8 kg/cm^2 at the gun end. The nozzle shall be heldat sucha distance(65 to100cm) and positionsothat thestratumof flowing materials shall impinge as nearly as possible at right angles to the surface being gunited. All deposits ofloose sand shallbe removed prior to placinganylayer of gunite. Gunite shall be shot in one coat to the specified thickness. Every precaution shall be taken to prevent the formationof sand pockets and if any develop, they shall be cut out and replaced with satisfactory machine placed material. No hand patching will be allowed. The Contractor shall apply the coating in such a manner that no sloughing shall occur at any time during or following its application.

Gunite shall be placed in the top and sides of the pipe, then screeded to a uniform thickness and the ground lines or blocks removed. All rebound and

waste materials shall then be removed by air blowing and gunite placed in the bottom of the fittings and screeded. When completed, the coating shall be concentric with the barrel of an even thickness. The entire surface shall then receive a final flash coat of gunite and shall be steel towelled to a true surface equal in smoothnesstothespunlininginsuchamannernottoimpairthebondbetweenmortarandsteel

plate. The guniting and surface finishing shall complete in set and shall be applied continuously without the use of construction joints. In case, for any reason whatsoever, the cement does not adhere to the walls of pipes and sloughs off, swabbing the pipe with cement slurry shall not be permitted.

If foranyreasonitisnecessarytointerrupttheplacingofthe guniteforalength oftimethatwill result inthe material takinga permanent set,asquare shoulder shall be formedat the ends of the sections and/or elsewhere by shooting against a back or by working with a trowel or other suitable tools the irregular edges of the material last placed to a clean unbroken surface face perpendicular to the pipe that will provide a suitable connection or construction joint between such material and the material to be placed subsequently. When performing this work care shall be taken not to shatter or disturb the material remaining in place or disturb the embedded wire mesh. Before placing fresh material against the surface of such joints, they shall be carefully cleaned and wetted to ensure a good bond between the fresh material and that previouslyapplied.

Theungunitedportionat theendsof thepipelengthsleft forthepurposeoffieldweldingshall be coated with M15 concrete by hand after the field welding and hydraulic testing are completed.

- **Curing**

After the mortar has set, but not later than twelve (12) hours after application of the coating, curingshallbecommenced.Coatingshallbekeptcontinuouslymoistandinthesha deforatleast 14 days.

- **Inspection**

Pipe coatings shall be inspected prior to transports, to laying site and broken, defective or otherwise unsatisfactory areas may be rejected at any time during construction. All defective areas shall be made good to the satisfaction of the Engineer. Coating cracks over 0.25 mm wide or over 500 mm long shall be made good.

- **Tests**

Compressivestrengthtestofconcreteshallbeconductedon150mmcubesinaccordancewithIS 516. The number of tests shall be at least 4 cubes for each age and each water cement ratio for each days work. The concrete mix shall have a minimum characteristic compressive strength of 25 N/mm^2 at 28 days.

- **FiberReinforcedCoalTarEnamel Coating**

Unless otherwise specified or stated on the drawings the pipeline of diameter 1000 mm and less to be laid underground and the exposed pipeline supported on saddles shall be externally coated with Fiber Reinforced Coal Tar Enamel at pipe manufacturing mill.

CHAPTER-12

RESTORATIONOFROADS

Definitions

The words like Contract, Contractor, Engineer (synonymous with Engineer-in- charge), Drawings, Employer, Government, Works and Work Site used in these Specifications shall be considered to have the meaning as understood from the definitionsofthese terms givenintheGeneral Conditionsof Contract.

Thefollowingabbreviationsshallhavethemeaningassetforthbe

low: MOSRTH : Ministry of Shipping, Road Transportation and

Highways

IRC :IndianRoadsCongress

IS :

IndianStandardpublishedbytheBureauofIndian"Standards

GSB : GRANULAR SUB BASE

WMM :WETMIXMACADAM

BM : BITUMINOUS

MACADAM BC :

BITUMINOUS CONCRETE

CBR : CaliforniaBearingRatio

AASHTO :AmericanAssociationofStateHighwayandTransportation Officials

ASTM : AmericanSocietyforTestingandMaterials

BS : BritishStandardpublishedbytheBritishStandardsInstitution

ApplicableCodesandSpecifications

Thefollowingspecifications,standardsandcodesarereferredtointhispart.

IS : 460 :SpecificationforTestsieves (Parts 1 to 3)

IS:1077 :Commonburntclaybuildingbricks -Specification

IS : 1124 : Method of test for determination of water absorption, apparent specificgravity and porosity of Aggregates /

stones

IS:1195 :SpecificationforBitumenMasticforFlooring

IS:1196 :CodeofPracticeforLayingBitumenMastic Flooring

IS:1834 :SpecificationforHotAppliedSealingCompoundsforJointsinConcrete

IS:2386 :Methodsoftestforaggregatesforconcrete(Parts1to 8)

IS : 2720 :Method of TestforSoils fordetermination ofLiquid andplastic limit. (Part 5)

IS : 6241 : Methodoftestfordeterminationofstripping valueofroadaggregates.

IRC : 16 : Specification for priming of Base Course with

Bituminous Primers. IRC : 17 : Tentative specification for Single

Coat Bituminous Surface Dressing IRC : 19

:Standardspecificationsandcodeofpracticeforwaterbound

macadam IRC : 29 : Specification for bituminous concrete

(Asphaltic Concrete)

forroadpavement.

MOSRTH

Specifications : Ministry of Shipping, Road transportation and Highways Specifications for Road and Bridge works

SECTION-101:GENERAL

SECTION-

301:EARTHWORK

SECTION-401 : GRANULAR SUB BASE
SECTION-502 : WET MIX MACADAM
SECTION-504 : BITUMINOUS MACADAM SECTION-509 : BITUMINOUS CONCRETE

RoadRestorationconfiguration

On laying of water lines / sewer lines in the trenches, the roads shall be restored to it's original condition in layers as per Drawing (Refer Standard drawings Volume 4) over the back fill as per concerned sections of MOSRTH

Technicalspecification:

a). Backfilloverthewaterlines/ sewerlinestothedesiredlevelasper drawing and specification.
b). Approved soil compacted in layers as per drawing, using soil deposited at site fromroad cuttingandexcavationtoachievecompactionlevelTable300-2andSection301 of MOSRTH Technical specification.

c). Layerofsand/ stonedustasperdrawingtoachieve97%relativecompactionof laboratory dry density to meet requirement of table 300-2 of MOSRTH specification.

d). GranularSubbaseaspersection401ofMOSRTHspecification.

e). Wet mix macadam (WMM) as per section 502 of MOSRTH specification.

f). Bituminous macadam (BM) as per section 504 of MOSRTH specification.

g). Bituminous concrete (BC) as per section 509 of MOSRTH specification.

Materials

General

All materials shall be obtained from local sources and shall conform to technical specifications and be subject to Engineer's approval prior to use.

Approved soil for Subgrade/ Embankment

The materials used in embankments, subgrades and miscellaneous backfills shall be soil, moorum, gravel, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/ subgrade.

The Contractor shall carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the backfill/restoration works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

It shall be ensured that the subgrade material when compacted to the density requirements as in **Table 5.1** (As per Table 300-2 of MOSRTH specification) shall yield the design CBR value of the subgrade.

Table 12.1: Compaction requirement for Subgrade (As per Table 300-2 of MOSRTH Specification)

Type of work/material	**Relative compaction as % of max lab dry density as per IS: 2720 (Part 8)**
Subgrade and earthen shoulders	Not less than 97
Embankment	Not less than 95

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval:

i) The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.

ii) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

iii) The Dry density-moisture content - CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he

intends to use in the subgrade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

GranularSubbase

The material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or

combination thereof depending upon the grading required. Materials like crushed slag crushed concrete, brickmetal and kankar maybe allowed onlywith thespecificapproval of the

Engineer. The material shall be free from organic or other deleterious constituents and conform to grading-iii given in **Table 5.2: Gradation for coarse graded granular Sub base.**

(AsperTable400-2ofMOSRTHSpecifications).

Table 12.2: Gradation for coarse graded granular Sub base. (AsperTABLE400– 2ofMOSRTHSpecification)

IS Sieve	**Percentbyweightpassingthesieve**		
Designation	**GradingI**	**GradingII**	**GradingIII**
75.0 mm	100	-	-
53.0 mm		100	
26.5 mm	55-75	50-80	100
9.50 mm			
4.75 mm	10-30	15-35	25-45
2.36 mm			
0.425 mm			
0.075 mm	<10	<10	<10
CBR Value (Minimum)	30	25	20

The CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions, which shall be taken as being the density relating to a uniform air, voids content of 5 per cent.

Note : The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

Coarse Aggregates

Coarse aggregate, stone chippings shall consist of natural or crushed stone, clean, hard, tough, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt, salt,alkali,vegetablematter,adherent coatings,organicandother objectionablematter,and shall conform to the physical requirements given in **Table 5.3** and **Table 5.4** hereunder, as applicable. Aggregate for bituminous wearing courses shall in addition have good hydrophobic properties i.e. capacity of retaining the film of bituminous material applied to the stone in all weather conditions and especially in wet conditions. Basalt, dolerites are good in this respect; granite, quartzites are comparatively poor.

Table–12.3:PhysicalRequirementsofCoarseAggregateforWetMixMacadam (WMM)

S.No	Test	Requirements	TestMethod
1	LosAngelesAbrasion Value*or Aggregate Impact Value*	40 percent 30 percent	IS:2386(Part–IV) IS:2386 (Part – IV) or IS:5640***
2	FlakinessIndex**	15percent(max)	IS:2386(PartI)

(*) Aggregatemaysatisfyrequirementsofeitheroftwotests.

(**)Requirementsofflakinessindexshallbeenforcedonlyincaseofcrushedbrokenstone.

(***) Aggregates like brick, metal, kankar, laterite etc., which get softened in presence ofwater,shall be tested for impact value under wet conditions in accordance with IS: 5640.

Table–12.4:PhysicalRequirementsofAggregatesforBituminousmacadam(BM)

S.No.	Test	Requirements	TestMethod
	LosAngelesAbrasionValue* Or AggregateImpactValue*	40percent(max.) 30percent(max.)	IS:2386(Part–IV) IS:2386(Part–IV)
	FlakinessIndex**	35percent(max.)	IS:2386(PartI)
	StrippingValue	25percent(max.)	IS:6241
	WaterAbsorption	2percent(max.)	IS:2386(Part-III)

	Soundness LosswithSodiumSulphate–5 cycles Loss with Magnesium Sulphate – 5 cycles	12 percent (max.) 18percent(max.)	IS:2386(Part-V)

(*)Aggregatemaysatisfyrequirementsofeitheroftwotests

(**)Requirementofflakinessindexshallbeenforcedonlyincaseofcrushedbrokenstone

Murum/Kankar/Gravel

Murum shall contain low plasticity binder material mixed with hard granular particles such as sand and/or gravel. Murum shall be sound and hard of a quality not affected by weather, to be screened at the quarry and free fromall impurities. Large lumps shall all be broken at the quarry and murum delivered at site must pass in every direction through a 63 mm ring. Murum shall not contain more than 5% to 8% of fines passing a 75 micron sieve.

Gravel shall be composed of large, coarse, silicious grains, sharp and gritty to the touch, thoroughly free from dirt, organic and deleterious matter. It shall be hard, tough, dense and shall not contain particles bigger than 12 mm and more than 10 percent silt.

Sand/StoneDust

The sand / Stone dust shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Motorized sand washing machines should be used to remove impuritiesfromsand.Fineaggregatehavingpositivealkali-silicareaction shall not beused. All fine aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, (Parts I to VIII). The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS: 383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5. The Sand used shall be coarse, sharp, gritty, clean, granular material. Only material passing through 4.75 mm sieve and retained on 75 micron sieve shall be used. The sand / Stone dust / fine aggregates shall conform to grading requirement in Table 5.5

Table 12.5 : Gradation requirement of Sand / Fine aggregates

(AsperTable1000-2ofMSORTHSpecifications)

ISSieveSize	**PercentbyWeightPassingthe Sieve**		
	ZoneI	**ZoneII**	**ZoneIII**
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

BituminousMaterials

Bituminous materials shall conform to IS: 73, IS: 215, IS: 217 or IS: 454 as applicable and be of the grade specified.

Table 12.6:PhysicalrequirementsofcoarseaggregatesforBituminous concrete(BC).

(AsperTABLE500-17:MOSRTHspecifications)

PROPERTY	TEST	SPECIFICATION
Cleanliness(dust)	Grainsizeanalysis	Max 5% passing 0.075mmsieve.
Particleshape	FlakinessandElongationIndex	Max 30% (Combined)2
Strength*	LosAnglesAbrasionValue3	Max 30%
	AggregateImpactValue4	Max 24%
Polishing	PolishedStoneValue5	Min55
Durability	Soundness:6 Sodium Sulphate MagnesiumSulphate	Max12% Max 18%
WaterAbsorption	Waterabsorption7	Max 2%
Stripping	CoatingandStrippingofBitumen Aggregate Mixtures9	Minimum retained coating 95%.
WaterSensitivity**	RetainedTensileStrength8	Min80%

Earthwork

Earthworkin Excavation

Ingeneraltheexcavationshallbeinaccordancetospecificationsspecifiedelsewhere.

Profiles of road excavation shall be laid at 50 m intervals or as specified in Drawings to conform to the required alignment, sections, grades and side slopes and the lines of cuts shall be clearly marked.

Contractor shall on no account excavate beyond the slopes or below the specified grade unless so approved by the Engineer in writing. If excavation is done below the specified level or outside the section the Contractor shall be required to fill up with approved materials, in layers of 150 to 200 mm, watered and compacted as specified for thesubgrade.

The excavation shall be finished neatly, smoothly and evenly to the correct lines, grades, sections as shown in the drawings or approved by Engineer.

Earthworkin Subgrade

The Subgrade shall be formed of approved soil excavated from road trenches and stacked separately.

Profiles of subgrade shall be set up with stout poles to mark the centre and edges of the formation with the top levels of formation clearly marked by paint or cut and the slopes with strings and pegs at every 10 metres on straight portions.

Subgrademateriallshallbeplacedinsuccessivehorizontallayersof200mmdepthextending tothefullwidthoftheSubgrade/trenchtoallowcompactionofthefullspecifiedsection to 150 mm using mini rollers / tampers / plate vibrators till the soil is evenly compacted to 95% of Proctor density with 2% variation in optimum moisture content. Before placing the

next layer of 200 mm the surface of the underlayer shall be moistured and scarified with pick axes or spades to provide a satisfactory bond with the next layer. The next layer shall also be
compacted to 150 mm to the full width of the trench section till the soil is evenlycompacted to 95% of Proctor density with 2% variation in optimum moisture content.

Whenboulders,brokenstonesandsimilarhardmaterialsaremixedupwiththeembankment
materialscareshallbetakentoseethattheyaredistributeduniformlyintothebankandthat no hollows are left near them. No stone or hard material shall project above the top of any layer. Each layer of embankment shall be watered, levelled, and compacted as specified beforethesucceedinglayerisplaced.Thesurfaceoftheembankmentshallatalltimesduring
constructionbemaintainedatsuchacrossfallaswillshedwaterandpreventponding.

If the soil contains less than the optimum moisture, water shall be added to the loose layers of the subgrade to bring the moisture uniformly upto requirement. If the material contains more than the required moisture it shall be allowed to dry until the moisture is reduced to the required extent. The moistured/dried loose layers shall be compacted with a vibratory roller / mini roller / plate vibrator/ tampers to achieve the desired compaction level of 95% of Proctor density.

CompactionwithSand/stonedust

In order to achieve better compaction and a compacted surface before laying the GSB layer, two layers of sand / stone dust shall be laid and compacted to 150 mm each.

PreparationofGranularSub-base(GSB)

Spreading and Compacting: The granular sub base material of **grade-iii** as specified in **Table 5.2: Gradation for coarse graded granular Sub base** (As per Table-2 of Section 401 – MOSRTH Specifications) shall be spread on the prepared sub grade maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub base material consists of combination of materials mentioned in clause 401.21, mixing shall be done mechanically by the mix in- place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small – sized jobs. The equipment used for mix-in-place construction shall be rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the

equipment shall be carried out to establish its suitability for the work.

Moisturecontentoftheloosematerialshallbecheckedinaccordancewith IS:2720(part2) andsuitablyadjustedbysprinklingadditionalwaterfromatruckmountedortrailermounted watertankandsuitableforapplyingwateruniformlyandatcontrolledquantitiestovariable widthsofsurfaceorothermeansapprovedbytheEngineersothat,atthetimeofcompaction, itisfrom1percentaboveto2percentbelowtheoptimummoisturecontentcorrespondingto IS: 2720 (part 8). While adding water, due allowance shall be made for evaporation losses. Afterwaterhasbeenadded,thematerialshallbeprocessedbymechanicaloratherapproved meanslikedischarrows,rotavatorsuntil thelayer isuniformlywet.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS: 2720 (part 8). The surface of any layer of materialoncompletionofcompactionshallbewellclosed,freefrommovemen tunder

compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re – compacted.

WetmixMacadamCourse (WMM)

The GSB layer surface over which Wet mix Macadam (WMM) is to be laid shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. WMM. sub-base course of specified thickness shall be provided. The course aggregate for this shall conform to requirements in **Table-5.7: Grading Requirements of Coarse Aggregates for Wet Mix Macadam (WMM)** (As per Table 400-11 of MOSRTH Specifications).

Table–

12.7:GradingRequirementsofCoarseAggregatesforWetMixMacadam (WMM) (As per Table 400-11 of MOSRTH Specifications)

ISSieveDesignation	**PercentbyweightpassingtheISsieve**
53.00 mm	100
45.00 mm	95 – 100
26.50 mm	-
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-8

PreparationofWMMlayer

Preparation of mix: Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary fromthe optimum value by more than agreed limits. The mixed material

should be uniformly wet and no segregation should be permitted.

Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenlyuponthepreparedsubgrade/sub-base/baseinrequiredquantities.In nocase

should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used so as to achieve the specified slope and grade. The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing oradding aggregate as may be required. The layer may be tested by depth blocks during construction.Nosegregationoflargerandfineparticlesshouldbeallowed.Theaggregates as spread should be of uniform gradation with no pockets of fine materials.

Compaction:Afterthemixhasbeenlaidtotherequiredthickness,gradeandcrossfall/camber thesameshall beuniformlycompacted,tothefull depth withsuitable vibratoryroller.The speed of the roller shall not exceed 5 km/h.

Primercoat

Primer:Thechoiceofabituminous primer shall depend uponthe porositycharacteristicsof the surface to be primed as classified in IRC: 16. Surface of low porosity; such as wet mix macadam. The primer shall be bitumen emulsion.

Primerviscosity:Thetypeandviscosityoftheprimershallcomplywiththerequirementsof IS 8887, as sampled and tested for bituminous primer in accordance with these standards. Guidance on viscosity and rate of spray is given in **Table-5.8: Requirement of Viscosity and quantity of Liquid bituminous Primer** (As per Table 500-1 of MOSRTH Specifications).

Table-12.8: Requirement of Viscosity and quantity of Liquid bituminous Primer
(AsperTable500-1ofMOSRTHSpecifications).

Typeofsurface	**Kinematic Viscosity of primer at 60° C (Centistokes)**	**Quantity of liquid BituminousMaterial per 10 Sq.m. (kg)**
Low porosity	30-60	6 to 9
Mediumporosity	70-140	9 to 12
Highporosity	250-500	12 to 15

Preparation of road surface: The surface to be primed shall be prepared in accordance with Clauses501.8.and902asappropriate.Immediatelypriortoapplyingtheprimer thesurface shall be carefullysweptclean ofdust and looseparticles, carebeingtaken not todisturbthe interlocked aggregate. Thisis best achieved whenthesurfacelayer is slightlymoist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

Application of bituminous primer: The viscosity and rate of application

of the primer shall be as specified in the Contract, or as determined by site trials carried out as directed by the Engineer. The bituminous primer shall be sprayed uniformly in accordance with Clause501 of MOSRTH specifications. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrateat asprayingtrial,thattheequipment and method to be used is capable of producing a uniform spray, within the tolerances specified. Curing of primer and opening to traffic: A primed surface shall be allowed tocure for at least 24 hours or such other period as is found to be necessary to allow all the volatilestoevaporatebeforeanysubsequentsurfacetreatmentormixislaid.Any

unabsorbed primer shall first be blotted with an application of sand, using the minimum quantity possible.

Tack coat

Over the primed surface, a tack coat should be applied in accordance with Clause 503 of MOSRTH Specifications.

The binder used for tack coat shall be bitumen emulsion complying with IS 8887 of a type and grade as specified in the Contract or as directed by the Engineer.

The tack coat distributor shall be a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, andanyextraneousmaterial,andbeotherwisepreparedinaccordancewiththerequirements of Clauses 501.8 and 902 as appropriate. Immediately before the application of the tackcoat, the surface shall be swept clean with a mechanical broom, and high pressure air jet, or by other means as directed by the Engineer.

The application of tack coat shall be at the rate specified in the Contract, and shall beapplied uniformly. If rate of application of Tack Coat is not specified in the contract then it shall be at the rate specified in **Table-12.9: Requirement of Viscosity and quantity of Liquid bituminous Tack Coat** (As per Table 500-2 of MOSRTH Specifications).

Table-12.9:RequirementofViscosityandquantityofLiquidbituminousTackCoat (AsperTable500-2ofMOSRTHSpecifications).

Type of Surface

QuantityofLiquidbituminous material in Kg per sq.m.area

i) Normalbituminoussurfaces 0.20to0.25

ii) Dryandhungrybituminoussurfaces0.25to0.30iii)Granularsurfacestreatedwithprimer0.25to0.30 i v)Non bituminous surfaces

Granularbase(not primed) 0.35 to0.40

Cementconcretepavement 0.30 to0.35

S.No.	TypeofSurface	Quantity of liquid bituminousmaterialinkg per sq.m area

1	Normalbituminoussurfaces	0.20 to0.25
2	Drybituminous surfaces	0.25 to0.30
3	Granularsurfacestreatedwithprimer	0.25 to0.30
4	Nonbituminoussurfaces	

	Granularbase(not primed)	0.35 to0.40
	Cementconcretepavement	0.30 to0.35

The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C and for a cutback, 50°C to 80°C.

BituminousMacadam

The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for “Paving Bitumen” IS:73.

Aggregate grading and binder content: When tested in accordance with IS: 2386 Part 1 (wet sieving method), the combined aggregate grading for the particular mixture shall fall within the limits shown in **Table-5.10: Composition of Bituminous macadam (BM)** (As per Table 500-4 of MOSRTH Specification) for the grading specified in the Contract. The type and quantityof bitumen, and appropriate thickness, are also indicated for each mixture type.

The aggregates shall be proportioned and blended to produce a uniform mixture complying with the requirements of Table 500-4.

Table-12.10: Compositionof Bituminous macadam(BM) (As per Table 500-4 of MOSRTH Specification)

Mixdesignation	**Grading1**	**Grading2**
Nominalaggregatesize	**40mm**	**19mm**
Layerthickness	**80-100mm**	**50-75mm**
ISSieve(mm)	**Cumulative %byweightoftotalaggregatepassing**	
45	100	
26.5	75-100	100
19	-	90-100
13.2	35-61	56-88
4.75	13-22	16-36
2.36	4-19	4-19
0.3	2-10	2-10
0.075	0-8	0-8
Bitumen content, % by weight of total	3.1-3.4	3.3-3.5
BitumenGrade	35to90	35to90

PreparationoftheBase

The base on which bituminous macadam is to be laid shall beprepared, shaped and compacted tothe required profile in accordance with Clause 501.8 and 902.3 as appropriate, or as directed by the Engineer.

PreparationandtransportationoftheMixture

TheprovisionsofClauses501.3and501.4shallapply.

Spreading

TheprovisionsofClauses501.5.3shallapply.

Compaction

Compaction shall be carried out in accordance with the provisions of Clause 501.6 and 501.7. The details of mixing, laying and rolling temperature of BM mix is as indicated in **Table- 5.11:Manufactring & rolling Temperature of BM mix** (As per Table 500-5 of MOSRTH Specifications)

Rolling shall be continued until the specified density is achieved, or where no density is specified, until there is no further movement under the roller. The required frequency of testing is defined in Clause 903.

Table-12.11:ManufactringRollingTemperatureofBMmix

(AsperTable500-5ofMOSRTHSpecifications)

Bitumen Penetration	**Bitumen Mixing (°C)**	**Aggregate Mixing(° C)**	**Mixed Material(° C)**	**Rolling (° C)**	**Laying (° C)**
35	160 -170	160-175	170 Maximum	100 Minimum	130 Minimum
65	150 -165	150-170	165 Maximum	90 Minimum	125 Minimum
90	140 -160	140-165	155 Maximum	80 Minimum	115 Minimum

Thebituminousmacadamshall becoveredwitheitherthenext pavement course or wearing course, as the case may be, within a maximum of forty-eight hours. If there is to be any delay, the course shall be covered by a seal coat to the requirement of Clause 513 before opening to any traffic. The seal coat in such cases shall be considered incidental to thework and shall not be paid for separately.

BituminousConcrete

This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous macadam (BM) surface.

Bitumen:The bitumen shall be pavingbitumen of Penetration grade complyingwith Indian Standard SpecificationforPavingBitumen, IS: 73 and of the penetration indicated inTable 500-18, for bituminous concrete.

The coarse aggregates shall be generally as specified in Clause 507.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-17.

Requirements for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in **Table-12.12: Composition of Bituminous Concrete** (As per Table 500-18 of MOSRTH Specifications) and **Table-5.13: Requirement of Bituminous Concrete** (As per Table 50019: of MOSRTH Specifications).

Table-12.12:CompositionofBituminousConcrete

(AsperTable500-18ofMOSRTHSpecifications).

Grading	**1**	**2**
Nominal aggregate size	**13 mm**	**10 mm**
LayerThickness	**35-40mm**	**25-30mm**
ISSieve[1](mm)	**Cumulative**	

	%byweightoftotalaggregatepassing	
45		
37.5		

26.5	100	
19	79-100	100
13.2	59-79	79-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-37	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumencontent% by mass of total mix[2]	5.0-6.0	5.0-7.0
Bitumengrade(pen)	65	65

Notes:1.Thecombinedaggregategradingshallnotvaryfromthelowlimitononesieve tothe high limit on the adjacent sieve.

2. DeterminedbytheMarshallmethod.
3. JobmixformulashallbegenerallyasspecifiedinClause507.3.3andtheresultso ftests enumerated in Table 500-19.

Table-12.13:RequirementofBituminousConcrete

(AsperTable500-19:ofMOSRTHSpecifications)

Percentair voids	3-6
Percentvoidsinmineralaggregate(VMA)	SeeTable500-12below
Percentvoidsfilledwithbitumen(VFB)	65-75
Loss of stability on immersion in water at 60ºC (ASTM D 1075)	Min.75percentretainedstrength

Rolling

Immediately after the spreading of mix it shall be thoroughly compacted by rolling with vibratoryrollersmovingat aspeednot morethan5kmper hour.Rollingshall becontinued till the mix is thoroughly compacted to meet the general provisions of clauses 501.6 and 501.7.

Openingto Traffic

Traffic shall be allowed on the road after a lapse of minimum 24 hours, preferably 48 hours after laying as approved by the Employer’s Representative.

QualityControlofRoadrestorationworks

General

For ensuring the requisite quality of construction, the materials and works shall besubjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to increase the frequencies of tests as he may deem necessary to satisfy himself that the materials and works comply with the appropriate Specifications.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the approval of the Engineer.

TestsonEarthworkforEmbankmentandSubgrade Construction

(i) Sand content [IS:2720(Part IV)] 1-2 tests per 8000 cu. metres of soil

(ii) PlasticityTest[IS:2720(PartV)] Eachtypetobetested,1-2testsper8000cu.metresofsoil.

(iii) DensityTest[[IS:2720(PartVII)]. Eachsoiltypetobetested,1-2testsper8000cubicmetresofsoil.

(iv) DeleteriousContentTest[IS:2720(PartXXVII)]

AsandwhenrequiredbytheEngineer.

(v) Moisture Content Test [IS:2720(Part II)] One test for every 250 cubic metres of soil.

(vi) CBR Test on materials to be incorporated in the subgrade on soaked/unsoaked samples [[IS:2720(part XVI)]

Onetestforevery3000m^3atleastorcloserasandwhenrequiredbytheEngineer.

Compactioncontrol

Controlshallbeexercisedbytakingatleastonemeasurementofdensityforeach500square metresofcompactedarea,orcloserasrequiredto yieldthe minimumnumber oftestresults for evaluation a days work on statistical basis. The determination of density shall be in accordance with IS:2720 (part XXVIII). Tests locations shall be chosen only through randomsamplingtechniques. Control shall not be based onthe result of anyone test but on the mean value of a set of 5-10 density determinations. The number of tests in one set of measurements shall be 5 as longas it is felt that sufficient control over borrow material and the method of compaction is being exercised. If considerable variations are observed between individual densityresults,the minimumnumber oftestsinonesetof measurement

shallbeincreasedto10.Theacceptanceofworkshallbesubjecttotheconditio
nthatthe

mean dry densityequals or exceeds the specified density and the standard deviation for any set of results is below 0.08 gm/cc.

However, for earthwork in subgrade and in top 500 mm portion of the embankment below thesubgrade,atleastonedensitymeasurementshallbetakenforevery100squaremetresof the compacted area provided further `that the number of tests in each set of measurements shallbeatleast10.Inotherrespects,thecontrolshallbesimilartothatdescribedearlier.

TestsonGranularSubbase(GSB)andWetmixmacadam(WMM) layers

The tests and their frequencies for the different types of bases and sub-base shall be asgiven in **Table 12.14**. The evaluation of density results for compaction control shall be on lines similar to those set out in clause 5.10.1.

Table–12.14:ControlTestsand their frequencies forGranularSubbase(GSB) and Wet mix macadam (WMM) layers

Sl.No.	Types of	Test	Frequency
1.	Granularsub-base	i) Gradation ii) Atterbergslimit iii) Moisture content prior to compaction iv) Densityofcompactedlayer v) Deleteriousconstituents	Onetestper200 m3 One test per 200m3Onetest per 250 m2 One testper500m2 As required
2.	Lime/ CementStabilised	i) Purityof lime(forlime-soil stabilization ii) Lime/Cementcontent iii) Degreeof pulverisation iv) CBRteston asetof 3specimens v) Moisture content prior to compaction vi) Densityofcompactedlayer vii) Deleteriousconstituents	Onetestforeach consignmentsubject to a minimumofone test per 5 tonnes of lime. Regularly, throughproceduralchecks. Periodically as considered necessary. As required One test per 250 m^3.Onetestper 500 m2 As
3	Wet mix Macadam	i) AggregateImpactValue	Onetestper200m^3 of aggregate

		ii) Grading iii) FlakinessIndex iv) Atterberg limits of portion of aggregatepassing425micron sieve	Onetestper100m^3 of aggregate Onetestper200m^3 of aggregate Onetestper100m3

S.No.	TypesofConstruction	Test	Frequency
1	Granularsub-base	1) Gradation	Onetestper200 m^3 Onetestper200 m^3 Onetestper250 m^2 Onetestper500 m^2 As required
		2)Atterbergslimit	
		3)Moisturecontentpriorto compaction	
		4)Densityofcompactedlayer	
		5)Deleteriousconstituents	
		6) C.B.R	
2	Lime/ CementStabilised	1)Purityoflime(forlime-soil stabilization)	One test for each consignment subject to a minimum of one test per 5 tonnes of lime. Regularly, through procedural checks. Periodicallyas considered necessary. A s required One test per 250 m^3. Onetestper500m^2 as required
		2) Lime/Cementcontent	
		3) Degree ofpulverisation	
		4)CBRtestonasetof3 specimens	
		5)Moisturecontentpriorto compaction	
		6)Densityofcompactedlayer	
		7)Deleteriousconstituents	
3	WetMixMacadam	1) AggregateImpactValue	Onetestper200m^3 of aggregate
		2) Grading	Onetestper100m^3 of aggregate
		3) FlakinessIndex	Onetestper200m^3 of aggregate
		4) Atterberg limits of portion of aggregate passing 425 micron sieve	Onetestper100m^3 of aggregate

TestsonBituminous Constructions

Thetestsand their frequencies forthe differenttypes of bituminous works shall beas given in **Table- 12.15** hereunder.

Table–12.15:ControlTestsandtheirFrequencyforBituminousWorks

S.No.	Types of Construction	Test	Frequency
1	Prime Coat/ Tack Coat	1)Qualityof binder	As Required
		2)Bindertemperaturefor an application	Atregularcloseintervals
		3)Rateofspreadofbinder	Twotestsper day

2	Bituminousmacadam (BM)/ Bituminous Concrete(BC)	1)Qualityof binder	As required

S.No.	Types of Construction	Test	Frequency
		2) Aggregate impact value, flakiness index and stripping value of aggregates	Onetestper50-100$m^3$of aggregate
		3)Mix-grading	One set of test on individual constituents and mixed aggregates from the dryer for each 100tonnesofmixsubject to amaximumoftwosets perplantperday.
		4) Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling	Atregularcloseinterval
		5)Stabilityofmix(vide ASTM: D-1559)	For each 100 tonnes of mix produced, a set of three Marshall specimens to be prepared and tested for stability, flow value, density and void content subject to a minimum of twosetsbeingtested per plantperday.
		6) Binder content and gradation in the mix (Binder contenttestvideASTM:D-2172)	One test for each 100 tonnesofmixsubjecttoa minimumoftwotests per dayperplant.
		7)Rateofspreadofmixed material	Regular control through checks on the weight of mixed material and layer

			thickness.
		8)Densityocompactedlayer	Onetestper250m^2area

CHAPTER-13

ACCEPTANCETESTS

CHECKFOROBSTRUCTION

a. As soon as a stretch of pipes whether of stoneware or cast iron or RC Pipes has been laid Complete from machine holes to machine holes, the Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less indiameter than the internal diameter of the pipes. The open end of an incomplete stretch ofpipelineshallbesecurelyclosedasmaybedirectedbytheEngineertoprevent entryof mud or silt etc.

b. If as a result of the removal of any obstruction the Engineer considers that damages mayhave been caused to the pipe lines, he shall be entitled to order the length to be retested attheexpenseoftheContractor.Shouldsuchretestproveunsatisfactory theContractorshall at his own expense amend the work and carry out such further tests as are required by the Engineer.

c. It shall also be ascertained by the Contractors that each stretch from machine holes to machine holes is absolutely clear and without any obstruction by means of visualexamination of the interior of the pipe line.

HYDRAULICTESTINGOFSEWERS

Immediately after the test with the double disc or cylinder as mentioned above has been completed and any defects thereby disclosed have been made good, the Contractor shall prove the joints of the stretch of under-ground pipes whether of stoneware, cast iron or RC Pipes, to be water tight.

Each section of sewer shall be tested for water tightness preferably betweenmachine hole.To prevent change in alignment and disturbance after the pipes have been laid, it is desirable to backfill the pipes up to the top keeping at least 90 cm length of the pipe open at the joints. However, this may not be feasible In the case of pipes of shorter length, such as stoneware and RCC pipes. With concrete encasement or concrete cradle, partial covering of the pipe is not necessary.

In case of lowered stoneware pipes with cement mortar joints, pipes shall be tested threedays after the cement mortar joints have been made. If it is necessary that the pipelines are filled with water for 7 daysbefore commissioningtheapplication of pressure toallow for the absorption bypipe wall. Wherethereis obstructiontotrafficthe period of 7 daysallowed for absorption by pipe wall can be reduced by the engineer at his decision.

TheSewersaretestedbypluggingtheupperendwithaprovisionforanairoutlet pipe with stop cock. The water is filled through a funnel connected at the lower end providedwithaplug.Aftertheair hasbeenexpelledthroughtileairoutlet, thestopcock isclosed andwaterlevelinthefunnelisraisedto1.5m abovetheinvertattheupperend.Water levelinthefunnelisnotedafter30minutesandthequantityofwaterrequiredis measured at an interval of 10 minutes to restore the original water level in the funnel. The pipelineunderpressureistheninspectedwhiletilefunnelisstillinposition.The reshall not be any leaks in the pipe or the joints (small sweating on tile pipe surface is permitted), any sewerorpartthereofthatdoesnotmeetthetestshallbeemptiedandrepairedor re-

laidasrequiredandtestedagain.Theleakageorquantityofwatertobesupplied to
maintainthetestpressureduringtheperiodof10minutesshallnotexceed0.2litres/mm dia, of pipes per kilometre length per day.

Waterandotheraccessoriesrequiredfortestingshallbetotheaccountofthecontractor.

AIRTESTINGOFSEWER

Theair test is to be conducted forsewers before backfilling. It should not be usedfor testing after back filling or if the trench is water logged as under those conditions it is possible for a faulty line to be satisfactory.

Therequirementsofthecodesofpracticefor theair testarethat thelengthofpipeunder test should be effectively plugged and air pumped in by suitable means until a pressure of100 mm of water is indicated in a glass U-tube connected to the system. The air pressure should then not fall to less than 75 mm I during a period of 5 minutes without further pumping, after allowing a suitable time for stabilization of the air temperature. In case the drop is more than 25 mm the leaking joints shall be traced and suitably treated to ensure watertightness.Theexactpointofleakagecanbedetectedbyapplyingsoapsol utionto all the joints in the line and looking for air bubbles.

TESTINGOFMACHINEHOLE

The entire height of the machine holes shall be tested for water tightness by closing both the incomingand outgoingends of the sewer and fillingthe machine holes with water. A drop in water level not more than 50 mm per 24 hours shall be permitted. In case of high sub-soil water,itshouldbeensuredthatthereisnoleakageofgroundwaterintothe machineholesby observing the machine holes for 24 hours after emptying it.

Water and other accessories required for testing shall be arranged by the contractor at hisown cost.

SECTION7A:TECHNICALSCHEDULES

INDEXTOTECHNICALSCHEDULES

Schedule	Particulars
	PreambletoTechnicalSchedules
I	Construction Programme
II	Subcontracting
III	TechnicalDetailsofPlant/ EquipmentProposedtobeincorporatedinto the Works
IV	Electricalworks
V	StatementofDeviationsfromtheTechnicalSpecifications
VI	SafetyPlan
VII	EnvironmentalManagementPlan
VIII	QualityAssuranceandQualityControlPlan

PREAMBLETOTECHNICAL SCHEDULES

1. Bidders are required to provide full and complete information as detailed in the following Schedules. All Schedules are requiredto be completed, but Bidders should not necessarily restrict themselves to using the space that is provided; Bidders will beresponsibleforprovidingadditionalsheets/pagesand/orsupplementaryinformationwherevernecessary tofullycommunicatetherequiredinformation.Theinformation willbeexamined toassessthecapabilityofthebiddertocarryout thework in accordancewith the requirements of the Contract.

2. In the event that any particular Schedule or item in the Schedule is not applicable, the Bidder shall clearly indicate the same and provide full and complete justification regarding why it is not applicable.

3. The Employer wishes to clarify that regardless of what is proposed by the Bidder, the successful Bidder shall be required to conform in all respects to the requirements of the Contract, and all proposals shall be subject to the approval of the Engineer.Acceptance ofthe Bidder's proposal for the purposes of bid evaluation shall not be construed as approval by the Employer. All details will subsequently be subject to the approval of the Engineer during execution oftheContract.No claimforadditional payments shall beentertained,otherthanin accordance with the Contract.

4. Pursuant to Sub-Clause 17, Instructions to Bidders, Volume 1, information provided by the Bidders in Technical Schedules (attached in Volume 2) will be assessed to determine whether bidder meets the qualification criteria.

5. BiddershallsubmitseparateTechnicalSchedulesfortheeachSTP&ISPSseparately.

The Bidder shall note that, pursuant to Sub-Clause 22.2 of Section 1, Instructions to Bidders, bidder is required to affix bidder's seal and authorized signature on all pages of this Section, Technical Schedules.

SCHEDULE I

CONSTRUCTIONPROGRA

MME

The Tenderer shall submit a realistic construction programme which he proposes to adopt for executing the Works. This shall be in sufficient detail so as to show the order and duration of keyactivities required to carryout the Works (including each stage of mobilization of labour, setting up of site offices/ workshops/ pipe manufacturing plants, consents and approvals, procurement, manufacture, pre-delivery inspection and testing, delivery to Site, construction, erection, testing and commissioning).

The Tenderer should pay particular attention to ensuring that the proposed programme is integrated with the Method Statement.

The construction programme shall be developed and presented on a commercially available project management software (such as Primavera, MS Project or equivalent), together with bar charts and CPM diagrams which clearly illustrate the critical path to achieve the desired results.

SCHEDULE II

SUBCONTRACTI

NG

The Tenderer shall enter in this Schedule a list of the sub-components and approximate value (intermsofpercentageofCostofConstructionWorks)oftheconstructionworkf orwhichhe proposes to use subcontractors, together with the names and addresses of the proposed subcontractors including specialist subcontractors. The Tenderer shall also enter a statement of similar works previously executed by the proposed subcontractors, including description, location and value of work, year completed, and name and address of the Engineer. The Contractor shall provide evidence from the Engineer that the subcontractor has previous successful experience in carrying out the works of a similar nature as the Contract. Notwithstanding such information, the Tenderer, if awarded the Contract, shall remain entirely and solely responsible for the satisfactory completion of the Works.

Components Proposed to be Executedthrough Subcontracts	**Approximate Value (asPercentage of Cost of Construction Works)**	**Name and Address of Proposedsubcontractor**	**Whether Specialist Sub-contractor or Not**	**Statement of Similar Works Executedwithin last 10 years (Documentary Proof to be Enclosed)**

SCHEDULEIII

TECHNICALDETAILSOFPLANT/EQUIPMENTPROPOSEDTOBE INCORPORATED INTO THE WORKS

SEPARATELYATTACHED

SCHEDULEIV

ElectricalWorks

SEPARATELYATTACHED

SCHEDULEV

STATEMENTOFDEVIATIONSFROMTHETECHNICAL SPECIFICATIONS

The Tenderer shall describe all proposed deviations from the specifications and Drawings set out under Volume 2: Specifications, clause by clause, in this Schedule.

The Tenderer should note that the specifications given in the Tender Document are the minimum acceptable, and that onlystandard those are better / higher than the ones referred to in the Tender Document will be acceptable.Acceptance of the Tender shall not be construed as approval by the Employer of any deviations from the Technical Specifications. All details will be subject to the approval of the Engineer during execution of the Contract.

Sub-Section Number	TitleofSub-section	Clause No.	Specification as per Tender Document	Deviation &Specifications Proposedwith standardcode reference	Reasons for Deviation

The Tenderer hereby certifies that the above mentioned deviations are the only deviations from the technical specifications set forth under

Volume 2:Specifications, and that he accepts all the remaining technical requirements of the Tender Document.

SCHEDULE

VI

SAFETYPLA

N

The Tenderer shall provide his proposed Safety Plan in detail so as to demonstratecompliance with the requirements set forth in, Volume 2: Specifications.

TheSafetyPlan shall include a policystatement signed bythe CEO or equivalent authorityof the Organization declaring that Safety and loss prevention shall be given the highest practicable priority in all aspects of the Contract.

TheTenderershalldescribehisproposedSafetyPlanwhich shallbedevelopedto ensurezero fatal accidents and zero hazardous incidents/occurrences in all construction works, including descriptionsofthecompany'sstandardpoliciesandproceduresregardingitssiteorganization and procedures, methods and frequency of conducting safety audits at the Site(s), record keeping and reporting, providing safetytraining for its personnel, issue and mandatoryuse of safety equipment, and details of the qualifications and experience of the Tenderer's proposed safety officers to be deployed at the Site(s).

The Tenderer shall provide descriptions of its proposed Safety Plan during the construction phase.

This will be an initial SafetyPlan which will address to the safetyof all persons entitled to be at site including the Employer's personnel.

SCHEDULE VII

ENVIRONMENTALMANAGEMENTPLAN

The Tenderer shall provide his proposed Environmental Management Plan in detail so as to demonstrate the procedures that will be used to ensure that the environmental concerns and requirements as set forth in, Volume 2: Specifications are satisfactorily met.

The Environment Management Plan shall identify the potential environmental impacts from the various construction and operations and maintenance activities to be undertaken in the Contract and set out in detail the approach he will adopt in mitigating these environmental impacts to ensure that the residual impacts are minor and confined to a short period.

While preparing the proposed Environmental Management Plan the Tenderer shall consider but not be limited to the following:

- The Tenderer shall pay attention to the methods of materials delivery, storage, usage and disposal; equipment usage; and site activities to ensure they have minimal impact on the environment,
- TheTenderershallproposeonlyenvironmentallysafeproductsandpractices inperforming his works, and
- TheTenderer shall complywith all of thestatutes regardingenvironmental effects.

The Tenderer shall provide descriptions of its proposals for minimizing any adverse environmental impacts/effects during the construction phase.

This will be an initial Environmental Management Plan (EMP) which will address all moderate significant negative impacts of pipeline construction activities.

SCHEDULEVIII

QUALITYASSURANCEANDQUALITYCONTROL PLAN

The Tenderer shall provide copies of the company's standard rules and regulations regarding quality assurance and quality control procedures for works in general and works of a similar nature.

The Tenderer shall provide its proposed QualityAssurance and QualityControl Plan in detail so as to demonstrate the procedures and tests that will be used to ensure that the quality concerns and requirements as set forth in, Quality Assurance as given in Volume 2: Specifications are satisfactorily met.

Theproposed plan will describebut notlimited to:

- thetype,frequencyandprocedureofteststobedoneonsites;
- type, frequency and procedure of tests to be done in pipe manufacturing units at site,if applicable;
- type, frequency and procedure of tests to be done at manufacturers' locations outside the sites;
- all parameters to be measured in these tests; permissible limits of such parameters; details of laboratories to be established at sites; details of testing equipments & machines and their calibration schedules
- details of the Tenderer's internal systems for assuring quality control at the manufacturers' works outside the sites;
- details of qualifications and experience of the Quality Control professionals to be deployed for the entire project; and
- the systems of Quality Audit to be instituted for systematic and professional management as well as adherence with the highest standards of quality of all construction works.
- All the tests of samples taken from the site are proposed to be done through recognized test houses of international standards and number of samples and frequency of sampling of materials brought to the site and the products manufactured at site shall be as per I.S. Specifications. All such samples shall be taken in the presence of Employer's authorized representatives or the Engineer.

The Tenderer shall provide descriptions of its proposed QA/QC plan during the construction phase.

This will be an initial QA/QC plan which will address to basic requirements of Quality control and Quality assurance of the works.

TECHNICALDETAILSOFPLANT/
EQUIPMENTPROPOSEDTOBEINCORPORATEDINTO THE WORKS
(TobecompletedbytheBidder)

I. MechanicalWorks-ISPS

A. NonClogSubmersibleSewagePumps-ISPS

SI. No.	Description	Units	Particulars
(a)	**General**		
	(i) Make		
	(ii) Model		
	(iii) Quantity(W+S)		
	(iii) Type		
(b)	**Performance**		
	(i) Capacity	cum/hr	
	(ii) TotalHead	mlc	
	(iii) Efficiency	%	
	(iv) Maximumpumpinputat50 Hz for single pump operation	kW	
	(v) ShutoffHead	mlc	
	(vi) Rated Speed	rpm	
	(vii) Sizeofsolidsthatcanbe handled	mm	
(c)	**Design/Construction**		
	(i) TypeofImpeller(enclosed/ semi open)		
	(ii) No.ofImpellervanes	nos	
	(iii) ImpellerDiameter	mm	
	(iv) NPSHR	m	
	(iv) Minimumsubmerg ence required	mm	

SI. No.	Description	Units	Particulars
	(v) Surfacehardnessofshaft sleeve	BHN	
	(vi) Dischargesize	mm	
	(viii) Weight	kg	
(d)	**Materialsof Construction**		
	(i) Impeller		
	(ii) Casing		
	(iii) Shaft		
	(iv) Motor housing		
	(v) ShaftSleeve		
	(vi) MechanicalSeal(motorside)		
	(vii) MechanicalSeal(pump side)		
	(viii) Autocouplingwithintegral bend		
	(ix) Liftingchain		
	(x) Guidepipe		
	(xi) Fasteners		
(e)	**Testingand Inspection** (i) PumpPerformancetesting Standard		
(f)	**Performance** (i) Maximumvelocityof vibration	mm/ sec	
	(ii) Maximumnoise level	dB(A)	

Note:ISPS-IntermediateSewagePumpingStation

B. **SubmersibleInductionMotor-ISPS**

S. No.	Description	Units	Particulars
(a)	Make		
(b)	Quantity(W+S)	Nos.	
(c)	Rating	kW	
(d)	Speed	rpm	
(e)	Typeof Starter		
(f)	Efficiency • FullLoad • ¾ Load	 % %	
(g)	PowerFactor • FullLoad • ¾ Load		
(h)	Classof Insulation		
(i)	Startingmethod		
(j)	Temperaturerisebyresistance method	°C	
(k)	Typeof enclosure		
(l)	Degreeof protection		
(m)	Weight	kg	
(n)	Coolingarrangementformotor		
(o)	Degreeof Protection		

C. MechanicallyRakedBarScreen–ISPS

S. No.	Description	Units	Particulars
(a)	**General** (i) Make		
	(ii) Model		
	(iii) Quantity(W+S)		
	(iii) Type		
(b)	**Screen** (i) Width	mm	
	(ii) Height	mm	
	(iii) Barsize(frontxbackx depth)	mm x mm x mm	
	(iv) Clearspacebetweenbars at front end	mm	
	(v) Typeorrakingarrangement		
	(vi) Rakingspeed	m/min	
	(vii) Motor rating	kW	
(c)	**MaterialsofConstruction** (i) Frame		
	(ii) Rakecarriage		
	(iii) Screenbars		
	(iv) Tines		
	(iv) Fasteners		
	(v) Canopy		
(d)	**BeltConveyorSystem**		
	(i) Materialofbelt		

S. No.	Description	Units	Particulars
	(ii) Widthof conveyor	mm	
	(iii) Speedofconveyor	m/sec	
	(iv) Thicknessofbeltandply rating		
	(v) Makeofthe belt		
	(vi) Motorrating	kW	
(e)	**UnitControlPanel** (i) Make		
	(ii) Circuitbreaker rating	A	
	(iii) Overalldimensions	mm x mm x mm	
	(iii) Degreeof protection		
	(iv) Timer		
	• Make • Type		

D. Manually(J-type)BarScreen –ISPS

Sr. No.	Description	Unit	Particulars
(a)	**General** (i) Make		
	(ii) Size	mmx mm	
(b)	**Screen** (i) Width	mm	
	(ii) Height	mm	
	(iii) Barsize	mmxmm	
	(iv) Clearspacebetweenbars	mm	
(c)	**Materialsof Construction** (i) Screenbars		
	(ii) Guide channels		

E. **ElectricallyOperatedCrane–ISPS**

S. No.	Description		Units	Particulars	
				WetWell Area	**Screen Area**
(a)	**<u>ElectricHoist</u>**				
	(i)	Make			
	(ii)	Typeandclass			
	(iii)	SafeworkingLoad	tonne		
	(iv)	Hoistspeed high/low	m/min		
	(v)	LongTravel speed	m/min		
	(vi)	Crosstravelspeed	m/min		
	(vii)	Span	m		
(b)	**<u>HoistingRope:</u>**				
	(i)	Diameter	mm		
	(ii)	Construction			
	(iii)	Qualityofsteel			
	(iv)	MinimumBreakingLoad	kgs		
	(v)	Factorof safety			
(c)	**<u>MotorsforHoist/Long travel/:</u>**				
	(i)	Make			
	(ii)	Type			
	(iii)	Rating	kW		
(d)	**<u>DetailsofBrakesforHoist/ crosstravel/Long travel:</u>**				
	(i)	Make			
	(ii)	DesignHoldingTorque	N-mm		
	(iii)	Netweight	kgs		

F. **Sluice&Weir Gates**[+]

S. No.	Sub S. No.	Description	Units	Particulars
(a)	(i)	Make		
	(ii)	Model		
	(iii)	Quantity(W+S)		
	(iv)	Service		
	(v)	Type		
	(vi)	SpindleType		
	(vii)	Size	mm x mm	
	(viii)	Weight	kgs	
	(ix)	SeatingHead	m	
	(x)	UnseatingHead	m	
(b)		**Materialof construction:**		
	(i)	WallThimble		
	(ii)	Gate		
	(iii)	Frame		
	(iv)	Spindle		
	(v)	Stemcoupling		
	(vi)	Seatingface		
	(vii)	Wedge		
	(viii)	Headstock		
	(ix)	GearHousecover&stem guide		
	(x)	LiftNut		
	(xi)	Fasteners& Anchors		

S. No.	Sub S. No.	Description	Units	Particulars
	(xii)	Liftingmechanism,Gear House & stem guide		
(c)		**GateActuators+**		
	(i)	Make		
	(ii)	Type		
	(iii)	Model		
	(iv)	Service		
	(v)	Number	Nos	
	(vi)	Motor Rating	kW	
	(vii)	Motor speed	rpm	
	(viii)	Protection		
	(ix)	GearReducerMake		
	(x)	Type		

+BiddertoprovideabovedetailsforeachsizeofGateand Service

G. **Valves#**

S. No.	Sub S. No.	Description	Units	Particulars
(a)		**Non-returnvalves#**		
	(i)	Make		
	(ii)	Type		
	(iii)	Model		
	(iv)	Service		
	(v)	Quantity(W+S)	Nos.	
	(vi)	Size	mm	
	(vii)	Rating	PN	
	(viii)	Test Pressure	bar	
	(ix)	Designstandard		
		Material of construction:		

S. No.	Sub S. No.	Description	Units	Particulars
	(i)	Body		
	(ii)	Door		
	(iii)	Seatring		
	(iv)	Shaft		
	(v)	Flangedrillingstandard		
(b)		**KnifeGatevalves:#**		
	(i)	Make		
	(ii)	Type		
	(iii)	Model		
	(iv)	Service		
	(v)	Number		
	(vi)	Size	mm	
	(vii)	Rating	PN	
	(viii)	Test pressure	bar	
	(ix)	Bodymaterial		
	(x)	Gatematerial		
	(xi)	Sealingface material		
	(xii)	Shaftmaterial		
	(xiv)	Gear Reducers		
	(xv)	Gear Make		
	(xvi)	GearMaterial		
	(xvii)	FlangeDrillingstandard		
(c)		**KnifeGateValve Actuators #**		
	(i)	Make		
	(ii)	Type		
	(iii)	Number		
	(iv)	Motor rating	kW	
	(v)	DesignTorque	N-m	

S. No.	Sub S. No.	Description	Units	Particulars
	(vi)	Timeforfullopentofull close	Seconds	

#Biddertoprovideabovedetailsforeachsize,typeofValveand Service

H. DewateringPumps

S. No.	Sub S. No.	Description	Units	Particulars
(a)	(i)	Make		
	(ii)	Type		
	(iii)	Service/Location		
	(iv)	Quantity(W+S)	Nos.	
	(v)	Capacity	cum/hr	
	(vi)	Head	mlc	
	(vii)	Efficiency	%	
	(viii)	Powerabsorbed	kW	
	(ix)	Speed	rpm	
	(x)	Motor rating	kW	

I. Valvesin PumpingMain

S. No.	Sub S. No.	Description	Units	Particulars
(a)		**Knifegatevalvein Pumping Main**		
	(i)	Make		
	(ii)	Type		
	(iii)	Model		
	(iv)	Service		
	(v)	Number	Nos	

S. No.	Sub S. No.	Description	Units	Particulars
	(vi)	Size	mm	
	(vii)	Rating	PN	
	(viii)	Test pressure	bar	
	(ix)	Bodymaterial		
	(x)	gatematerial		
	(xi)	Sealingface material		
	(xii)	Shaftmaterial		
	(xiv)	Gear Reducers:		
	(xv)	Make		
	(xvi)	Material		
	(xvii)	FlangeDrillingstandard		
(b)		**KnifeGateValve Actuators #**		
	(i)	Make		
	(ii)	Type		
	(iii)	Number		
	(iv)	Motor rating	kW	
	(v)	DesignTorque	N-m	
	(vi)	Timeforfullopentofull close	Seconds	
(c)		**AirValveinPumping Main**		
	(i)	Make		
	(ii)	Type		
	(iii)	Number	Nos	
	(iv)	Size	mm	
	(v)	Rating	PN	
	(vi)	Test pressure	bar	
	(vii)	Bodymaterial		
	(viii)	FloatMaterial		

S. No.	Sub S. No.	Description	Units	Particulars
	(ix)	NozzleMaterial		
(d)		**GatevalveinPumping Main**		
	(i)	Make		
	(ii)	Type		
	(iii)	Model		
	(iv)	Service		
	(v)	Number	Nos	
	(vi)	Size	mm	
	(vii)	Rating	PN	
	(viii)	Test pressure	bar	
	(ix)	Bodymaterial		
	(x)	gatematerial		
	(xi)	Sealingface material		
	(xii)	Shaftmaterial		
	(xiv)	Gear Reducers:		
	(xv)	Make		
	(xvi)	Material		
	(xvii)	FlangeDrillingstandard		
(e)		**Non-returnvalves#**		
	(i)	Make		
	(ii)	Type		
	(iii)	Model		
	(iv)	Service		
	(v)	Quantity(W+S)	Nos.	
	(vi)	Size	mm	
	(vii)	Rating	PN	
	(viii)	Test Pressure	bar	
	(ix)	Designstandard		

S. No.	Sub S. No.	Description	Units	Particulars
		Materialofconstruction :		
	(i)	Body		
	(ii)	Door		
	(iii)	Seatring		
	(iv)	Shaft		
	(v)	Flangedrillingstandard		

#Biddertoprovideabovedetailsforeachsize,typeofValveand Service

J. **PropellerExhaustFan**

Sr. No.	Sub S. No.	Description	Units	Particulars
(a)		Fan		
	(i)	Make		
	(iii)	Model		
	(iv)	Impellerdiameter	mm	
	(v)	Impellerspeed	rpm	
	(vi)	Capacity	cum/hr	
	(vii)	Static pressure	mmlc	
	(viii)	Shaftpower	W	
	(ix)	Fantotalefficiency	%	
(b)		**Motor**		
	(i)	Make		
	(ii)	Rating	kW	
(c)		**Overallweight**	kg	

K. ServiceWater Pumps

S. No.	Sub S. No.	Description	Units	Particulars
(a)	(i)	Make		
	(ii)	Type		
	(iii)	Service/Location		
	(iv)	Quantity(W+S)	Nos.	
	(v)	Capacity	cum/ hr	
	(vi)	Head	mlc	
	(vii)	Efficiency	%	
	(viii)	Powerabsorbed	kW	
	(ix)	Speed	rpm	
	(x)	Motor rating	kW	

L. Air-conditioningEquipment(ForSCADARoom)

S. No.	Sub S. No.	Description	Units	Particulars
(a)	(i)	Make		
	(ii)	Model		
	(iii)	Type		
	(iv)	Capacity	TR	
	(v)	Quantity	Nos.	
	(vi)	Motor Rating	kW	
	(vii)	Air-Ducting:		
	(viii)	Material		
	(ix)	Size		
	(x)	Quantity		
	(xi)	Whetherallthe required accessoriesareprovided	Yes/No	

Note:AllEquipmentshallbeofreputedmakeandshallqualifythecriteriaofthisBid document.

I.A	IntermediateSewagePumpingStation (ISPS)		ISPS
(b)	ScreenInfluentChannel		
	(i)	Sizeofinletchannel(m)	
	(ii)	Sizeofincomingsewer(m)	
	(iii)	Nos.Andsizeofgatedopeningsand type of gates	
	(v)	SizeofPlantBypass	
(c)	Screen Channels		
	(i)	No.Of units	
	(ii)	CapacityofeachunitinMLD	
	(iii)	Sizeofchannel(m)	
	(iv)	**Clearopeningofbarsinscreenat**	
	(vii)	Headloss (mm)	
(d)	CoarseScreenEffluent Channel		
	(i)	Sizeofinletchannel(m)	
(e)	Sizeof 415KVSwitchGearroom(mxmxm)		
(f)	SizeofValvechamber(mxmxm)		
(g)	ISPSWetWell/insidedimensionsand bottom slabinvertelevation,allinmeters		
(h)	ISPSValveChamberinsidedimensionsand bottom slab invert elevation, all in meters		
(i)	ISPSSuperstructuredimensions(L/W/ Dia,roof height) in meters		
(k)	Length,materialanddiameterofPumping Main from ISPS to STP		
(l)	Length,materialanddiameterofGravitySewer from to proposed ISPS		
(m)	TheBiddershalllistheredetailsofanyother/ additional items required for a complete installation.		

Note:1)SizesofunitsshallmeanLengthx WidthxDepth/Heightasapplicableandshallbe expressed in “metres” unless otherwise stated.

2)Biddershallfurnishdetailsinabovetableandwrite“NIL”wherevernotapplicableto the respective items.

ELECTRICALWORKS

(TobecompletedbytheBidder)

II. ElectricalWorks-ISPS

A. 11kVLoadBreakSwitch Panel

Sr. No	Description	Unit	TechnicalParticulars
1.1	RatedVoltage	kV	
1.2	Installation		
1.3	Rated Current	Amps	
1.4	PermissibleServicesVoltage	kV	
1.5	RatedShorttimecurrent	kA	
1.6	RatedMaking	kA(Peak)	
1.7	RatedInsulationLevel		
1.8	Rated Frequency	Hz	
1.9	No.ofPoles		
1.10	No.ofBreaks/ Pole		
1.11	ApplicableStandard		

B. 415VMetalEnclosed Switchgears

Sr. No	Description	Unit	TechnicalParticulars
I	**Make**		
II	**415VSwitchgearandBusbar Ratings**		
(a)	Ratedvoltagephaseandfrequency		
(b)	SystemNeutral Earthing		
(c)	Maximumsystemvoltage	V	
(d)	Oneminutepowerfrequency voltage		
	i)Powercircuits	V	2500
	ii)Controlcircuits	V	1500
	iii)Aux.Circuitsconnectedto Sec of CTS	V	2000
(e)	Continuous current rating of Busbars under site reference AmbientTemperatureandtype&	Rating Material	

Sr. No	Description		Unit	TechnicalParticulars
	material			
(f)	Busbarinsulation			
(g)	ReferenceAmbientTemperature		°C	
(h)	MaximumTemperatureofBusbars, Droppers and Contacts at Continuouscurrent ratingundersite ambient temperature		°C	85
(i)	ShortCircuitcurrentwithstand for Busbars and droppers (i)Shorttime1sec		kA(rms)	
	(ii)DynamicRating		kA(peak)	
III	**SwitchgearConstructional Requirement**			
(a)	Typeof Construction			
(b)	Thicknessofsheetsteel (i)Frame,Frameenclosures,doors, covers and partitions		mm	
(c)	Degreeof protection			
(d)	Colourfinish shade			
(e)	Earthingbus	Material		
		Size	mmxmm	
	Earthingconductor	Material		
		Size	mmxmm	
(g)	Minimumclearancesinairofl ive parts (i)PhasetoPhase		mm	
	(ii)PhasetoEarth		mm	
(h)	Cableentryto cubicles			
IV	**ChangeoverSwitch**			
(a)	ApplicableStandards			
(b)	Quantity		No.	
(c)	Rating		A	
(d)	Shortcircuitcurrentcapacityfor1		kA(rms)	

Sr. No	Description	Unit	TechnicalParticulars
	sec		
(e)	ProvisionofSafetyKeyLock	Yes/No	
(f)	AuxillaryContacts		
V	**InstrumentationTransformers**		
(a)	Currenttransformer		
	(i)Ratio		
	(ii)Burden	VA	
	(iii)AccuracyClass		
(b)	Voltagetransformer		
	(i)Ratio		
	(ii)Burden	VA	
	(iii)AccuracyClass		
VI	Whether all the above details attachedforallSwitchgearcubicles at Process Air Blower Building	Yes/No	
VII	ScheduleOfEssentialand Recommended Spares		

C. 415VPowerCapacitorandControl Panel

Sr. No	Description	Unit	TechnicalParticulars
I	**General**		
(a)	Make		
(b)	Rated Capacity	KVAR	
(c)	Rated voltage	V	
(d)	Ratedfrequencyandphases		
(e)	Ambienttemperature	^{o}C	
(f)	Cablegland required		
(g)	Typeof cable		
(h)	Sizeof cable		
(i)	Cableentry		
II	**ConstructionalRequirement**		
(a)	Thicknessofsheetsteel i)Frame,Frameenclosures,doors		

Sr. No	Description		Unit	TechnicalParticulars
	coversandpartition		Mm	
(b)	Degreeof protection			
(c)	Colourfinish shade			
(d)	Earthingbus	Material		
		Size	mmxmm	
(e)	Earthing conductor	Material		
		Size	mmxmm	
III	**Design Requirement**			
(a)	Insulationlevel		kV (rms)	
(b)	Capacitorbankconnection			
(c)	Shortcircuitwithstandforbusbars i)Shorttime(1sec)		kA(rms)	
	ii)Dynamic		kA(peak)	
(d)	Typeof switching			
(e)	Switchingsteps			
(f)	SwitchandRatingofcontactor			
(g)	IncomerMCCBcurrentrating			
(h)	O/Lcapacityof capacitors			
(i)	O/Vcapacityof capacitors			
(j)	Protections			

D. VariableFrequencyDrives

Sr. No.	Description	Unit	TechnicalParticulars
I	**General**		
(a)	Make		
(b)	Type		
(c)	ApplicableStandard		
(d)	DriveApplication		
(e)	Quantity	Nos	
(f)	Typeof converters		
(g)	Invertercapacityatspecifiedpf		

Sr. No.	Description	Unit	TechnicalParticulars
(h)	Rated Current		
(i)	Loadpower factor		
(j)	Max.continuouscurrent		
(k)	Ratedvoltagewithnumberof phases		
(m)	Rated frequency		
(n)	ConverterBridge		
(o)	SingleQuadrant/ Twoquadrant/ Four Quadrant		
II	ControlCharacteristics		
(a)	Speed Control		
(b)	Rated speed		
(c)	Speed ratio		
(d)	Constanttorque/constant power		
(e)	Speed accuracy		
(f)	Closedloop/openloop		
(g)	Accel./Deccel.time		
(h)	PossibilityofRemoteOperation	Yes/ No	
III	OverallHarmonicLimitation	%	
IV	Braking		
(a)	Typeof braking		
(b)	BrakingTorque		
V	Miscellaneous		
(a)	Soft-start	Yes/No	
(b)	Flyingrestart	Yes/No	
(c)	Auto restart	Yes/No	
(d)	KineticBuffering	Yes/No	
VI	Confirm whether following minimumIndicationsonDrive Panel are Provided	Yes/No	
(a)	Motor running		
(b)	Motorstopped/ trip		

Sr. No.	Description	Unit	TechnicalParticulars
(c)	ACmains'ON'		
(d)	SystemReadytostart		
(e)	VFDsystemfault		
VII	ConfirmwhetherDigitalDisplayof following Minimum parameters on the Drive Panels:-	Yes/No	
(a)	InputACVoltage		
(b)	InputACFrequency		
(c)	InputAC Current		
(d)	OutputVoltage		
(e)	OutputCurrentVFD/Bypass		
(f)	OutputFrequency		
(g)	Motor speed		
(h)	Whether Necessary transducers providedforindicatingmotorspeed & current in PLC/DCS.	Yes/No	

E. Cables

Sr. No.	Description	Unit	TechnicalParticulars
I	**6.6/11kV(E)GradeXLPE Insulated Power Cables**		
(a)	Make		
(b)	Type		
(c)	ApplicableStandards		
(d)	Cablesizeselectionwhetherdoneas per Specification	Yes/No	
(e)	Recommendedminimumbending radius	mm	
(f)	Standardlengthofcableoneach drum	mts	

Sr. No.	Description	Unit	TechnicalParticulars
II	**1100VGradePVCInsulated Power Cables**		
	Make		
	Type		
	ApplicableStandards		
	Cablesizeselectionwhetherdoneas per Specification	Yes/No	
	Recommendedminimumbending radius	mm	
	Standardlengthofcableoneach drum	mts	
III	**650/1100VGradePVCInsulated Control Cables**		
(a)	Make		
(b)	Type		
(c)	ApplicableStandards		
(d)	Rated voltage		
(e)	Cablesize selection		
(f)	Conductormaterial		
(g)	Insulation		
(h)	Innersheath		
(i)	Armouring		
(j)	Outersheath		
(k)	Standardlengthofcableoneach drum	mts	

F. LightingFixturesandAccessories

Sr. No.	Description	Unit	TechnicalParticulars
I	**General**		

Sr. No.	Description	Unit	TechnicalParticulars
(a)	Illumination levels at various premiseswhetherconsidere dasper Specification	Yes/No	
(d)	Normalsupplyvoltage,phasean d frequency	AC	
		DC	
(e)	Variationinsupply:		
	(i) Voltage(AC&DC)	%	
	(ii) Frequency	%	
	(iii)Combinedvoltage&frequen cy	%	
(f)	Designambientairtemperature	^{0}C	
II	Luminaireterminalsuitablefor		
(a)	Indoor area		
	(i)Conductor material		
	(ii)Cablesize	Coresxmm^2	
(b)	Outdoorarea		
	(i)Conductor material		
	(ii)Cablesize	Coresxmm^2	
III	Luminaireearthingterminals uitable for		
	(i)Conductor material		
	(ii)Conductor size	SWG	
IV	Luminaires		
(i)	Fluorescent Luminaires		
(a)	Make		
(b)	Type		
(c)	Rating		
(ii)	HPSV Luminaires		
(a)	Make		
(b)	Type		
(c)	Rating		

Sr. No.	Description	Unit	TechnicalParticulars
(iii)	FloodLight Luminaires		
(a)	Make		
(b)	Type		
(c)	Rating		

G. LightingSystemandEquipment

Sr.No.	Description	Unit	TechnicalParticulars
I	**SystemParticular**		
(a)	**Voltage**		
	(i)3Phase,4wire50Hzsystem		
	• Rated	V	
	• Maximum	V	
	• Oneminutewithst and voltage		
	(ii)D.C.system		
	• Rated	V	
(b)	Systemshort-circuitlevel		
	(i)At415V,A.C.	kA(rms)	
	(ii)At110V.D.C.	kA(D.C.)	
(c)	Referenceambienttemperature	^{0}C	
II	**DistributionBoard/Panels**		
(a)	Main,floormounteddistributi on boards		
(i)	MainLightingdistributionboa rd (A.C.)		
	• Make		
	• Type		
	• Degreeof protection		
	• Busbar material		
	• Busbarcurrent rating	A	

Sr.No.	Description	Unit	TechnicalParticulars
	• Shortcircuitcurrentrating	kA	
	• DetailsofIncoming and Outgoing feeders		
	• Cableentry		
	• Location		
(ii)	Emergencylightingpanel(D.C.)		
	• Make		
	• Type		
	• Degreeof protection		
	• Busbar material		
	• Busbarcurrent rating	A	
	• Shortcircuitcurrentrating	kA	
	• DetailsofIncominganda nd Outgoing feeders		
	• Cableentry		
	• Location		
(iii)	Single/threephaseDBs, wall/structuremounting		
	SLDB/TLDBforindoorarea		
	• Make		
	• Type		
	• DetailsofIncominganda nd Outgoing feeders		
	• Degreeof Protection		
(iv)	Single/ threephaseDBsforoutdoor area		
	• Make		
	• Type		
	• DetailsofIncoming and Outgoing feeders		
	• Degreeof Protection		

Sr.No.	Description	Unit	TechnicalParticulars
(v)	Paint Finish		
	(i)Colour shade:		
III (a)	**StreetLightPolesAndFloodLight Poles** StreetLightPole		
	Type		
	TotalHeight:	m	
	Quantity:	Nos.	
(b)	FloodlightLight Pole		
	Type		
	Totalheight:	m	
	Quantity:	Nos.	
	No.Offloodlightstobefixedper pole	No.	

H. EarthingandLightningProtectionSystem

Sr. No.	Description	TechnicalParticulars		
		Size	**Material**	**No.ofLeads & Quantity**
I (a)	**MainEarthingGrid** Buriedinearth			
(b)	Buriedinfloorslabsinbuildings			
II	**ConductorLeadsto Equipment** (aboveground)			
(a)	Transformers			
(i)	Transformerneutraltobottomof tank			
(ii)	Frombottomof tanktoearth grid			
(iii)	Transformertanksand			

Sr. No.	Description	TechnicalParticulars		
	radiatorbank			
(b)	DieselGeneratorSet			
(i)	DGSetneutralearthing			
(ii)	DGSetbodyearthing			
(c)	Fencepostsandgates(Flex. braid)			
III	11kVMetal Enclosed Switchboard,415Vswitch gear/ MCC.			
IV	Motors			
(a)	415VMotorsabove10kW			
(b)	415VMotorsupto10 kW			
(c)	Fractionalhorsepowermotors			
V	**OtherItems**			
(a)	Capacitor panel, Battery charger panel, DC distribution board, MainlightingD.B,Controlpanels and sub-lighting distribution boards etc.			
(b)	Hand Rails			
(c)	Cabletrays			
(d)	Tanks			
(e)	Junctionboxes			
(f)	Lightingfixtures,receptacles, lighting conduits			
(g)	Pushbuttonstations,limit switches			
VI	**Cranerail**			
VII	Streetlighting,floodlighting poles and junctions boxes			
VIII	Metallicnoncurrentcarrying structures			

Sr. No.	Description	TechnicalParticulars		
IX	**LightningConductors**			
(a)	Lightningprotectiondown comers for building			
(b)	Lightningprotectionhoriz ontal roof conductor for building			
X	**Electrodes**			
(a)	Pipeelectrode			

INSTRUMENTATION,CONTROL&AUTOMATIONEQUIPMENT
(Tobecompletedbythe Bidder)

III. InstrumentationWorks-ISPS

A. Instrumentation,Control&AutomationEquipments

S. No	Description	Unit	Particulars
i	**FlowMeasuring System** ElectroMagneticFlowMeter (i)MakeandModel (ii)Accuracy (iii)Principleofmeasurement (iv)MeasuringRange		
ii (a)	**LevelMeasuringSystem** RadarTypeLevelTransmitter(Non- Contact type) (i) Makeand Model (ii) Principleofmeasurement (iii) BeamAngle (iv) Accuracy		
(b)	**Level Switches** (i) Makeand Model (ii) Type (iii) NoofElectrodes (iv) Accuracy		

S. No	Description	Unit	Particulars
iii	**PressureIndicatingTransmitter** (i) Makeand Model (ii) Type (iii) Range (iv)Accuracy (v) output		
iv	**PressureGauges** (i) Makeand Model (ii) Type (iii) Accuracy (iv) Range		
v	**InstrumentationEarthing** (i) Makeand Model (ii)Typeof Material		
vi	**Two & Three Position Selector Switches (Including Electrical Accessories Like :-P.B's, LED's, MCB's e.t.c)** (i) Make (ii) Model		
vii	**SurgeProtectionDevicesfor instruments** (i) Surge Rating (ii) Make& Model		
viii	**JunctionBoxes&FieldEnclosures** (i) Make (ii) Model		

S. No	Description	Unit	Particulars
xi	**ProgrammableLogicControllerfor ISPS**		
(a)	(i) Make,Model&Series-PLC		
	(ii) Type-Standalone/Hot-Stand By:		
(b)	(iii) Expandabilityprovision-Yes /No		
	CPU,CommunicationModules, IndustrialEthernetSwitches		
(c)	(i) Make		
	(ii) ModelNo		
	Memory		
(d)			
	Number of Inputs(CPU, I/O & CommunicationModulesshallbe of the same series)		
	(i) DigitalInputs		
	(ii) ModelNo		
	(iii) Digitaloutput		
	(iv) ModelNo		
	(v) AnalogInputs		
	(vi) ModelNo		
	(vii) Analogoutputs		
(e)	(viii) Model No		
	InterposingRelayswithbase terminal		
	(i) Make		
(f)	(ii) Model		
	PowerSupplyModuleforPLC CPU		
	(i) Make		
(g)	(ii) Model No		
	Redundant GSM/GPRS Communicationmodulesfor IntegrationwithMIS-2,SCADA		

S. No	Description	Unit	Particulars
	centerasweasK&CValleySTP (i) Type,Make&ModelNo. (ii) Countryof Origin		
(h)	**PLCProgramming software** (i) SoftwareDetails (ii) Make& Model		
(i)	**HMI Software** (i) SoftwareDetails (ii) Make& Model (iii) No.ofTags		
(j)	**Engineeringworkstation(EWS)for PLC Programming software:** (i) SystemConfiguration (ii) Model (iii) MonitorSize (iv) Make		
xiii	**Operatorworkstation(OWS)for SCADA / HMI software:** (i) SystemConfiguration (ii) Model (iii) Monitorsize (iv) Make		
xiv	**SMPSforAutomation System** (i) Make (ii) ModelNo		
xv	**Multi-JetLaserPrinter** (i) ONLINE (ii) OFFLINE		

S. No	Description	Unit	Particulars
xvi	**InstrumentationControlPanelwith Internal Wiring** (i) Make (ii) ModelNo (iii) Pre-Fabricated		
xvii	Instrumentation (Analog) & Control Cables andPowerCables,OFC,Trays,Glands&Lugs ,cableconduits (i) Make (ii) NoofCores (iii) Type (iv) Size (v) Countryof Origin		
xviii	**UninterruptablePowerSupply** (i) Makeand Model (ii) Capacity (iii) No.ofbatteries (iv) Rating		
xix	**SplitCaseAirConditioner Unit:** (i) Capacity (ii) Qty.		

TECHNICALSCHEDULEIV

ELECTRICAL WORKS

(TobecompletedbytheBidder)

TheBiddershallsubmitthefilledinTechnicalParticularsfortheallltheEquipment/ Items as indicated under item no. 4.1.1 to item no4.1.14 in the prescribed format separately for Sewage Treatment Plants at various locations.

11kVMetalEnclosedSwitchboards/11kVOutdoorVCBPanel

Sr. No.	Description	Unit	TechnicalParticulars
4.1.1.1	Make		
4.1.1.2	Type		
4.1.1.3	ApplicableStandards		
4.1.1.4	Quantity	No	
4.1.1.5	Dimensions	mm	
4.1.1.6	**SwitchgearcubiclesandBus bar ratings**		
(a)	Ratedvoltage,phasesand frequency		
(b)	SystemNeutral Earthing		
(c)	Maximumsystemvoltage	kV	
(d)	Oneminutepowerfrequency withstand voltage	kV (rms)	
(e)	12/50μsecimpulsewithstandvoltage	kV (peak)	

Sr. No.	Description	Unit	TechnicalParticulars
(f)	Shortcircuitwithstand		
	(i)Shorttime(1sec)atrated voltage	kA(rms)	
	(ii)Dynamicrating	kA(peak)	
(g)	Referenceambienttemperature	˚C	
(h)	Maximum temperature of bus bars droppersconnectorsandcontacts at continuouscurrentratingunder site reference ambient temperature	˚C	
(i)	Continuouscurrentratingofbus bar	A	
(j)	Busbar material		
(k)	Busbar Insulation		
(l)	Cableentry		
(m)	CabletypeforIncomingand Outgoing feeders		
4.1.1.7	**Switchgearconstructional Requirement**		
(a)	Thicknessofsheetsteel Frame,Frameenclosures,doors, covers and partitions	mm	
(b)	Degreeof protection		
(c)	Colourfinish shade		
(d)	Earthingbus i)Material		

Sr. No.	Description		Unit	TechnicalParticulars
		ii)Size	mmxmm	
(e)	Earthingconductor	i)Material		
		ii)Size	mmxmm	
4.1.1.8	**BreakerParticulars**			
(a)	Circuitbreakertype			
(b)	Voltage,phasesandfrequency			
(c)	Ratedoperatingduty			
(d)	Ratedcurrentatreferenceambient temperature (i) Incomingbreakers		A	
	(ii)Outgoingbreakers		A	
(e)	Ratedbreakingcapacity		kA(rms)	
(f)	Ratedmakingcurrent		kA(peak)	
(g)	Shorttimecurrentwithstandfor 1sec duration		kA(rms)	
(h)	Totalbreaktime		milliseconds	
(i)	Operatingmechanismtype(Normal)			
	Operatingmechanismtype (Emergency)			
(j)	Minimumno.ofauxiliarycontacts			
(k)	Withstandtest voltage			
	(i)Oneminutepowerfrequency		kV (rms)	
	(ii)1.2/50μsecimpulse		kV (peak)	

Sr. No.	Description	Unit	TechnicalParticulars
(l)	Auxiliarycontrol voltage (i)Forclosing/tripping coil		
	(ii)Forspringchargingmotor		
	(iii)Forspaceheatersandlightin g		
	(iv)Permissiblevariationinoper ating voltage of closing & tripping coils		
(m)	Anti-pumpingfeature		
(n)	Latchingrequirement		
4.1.1.9	**Current Transformers**		
(a)	Type		
(b)	Classof insulation		
(c)	Ratedcurrentratioandburden (i) Incomersandbuscouplers		
	(ii)Outgoingfeeders		
(d)	Accuracyclass (i)Metering		
	(ii) Protection		
(e)	Shorttime1seccurrentrating	kA(rms)	
(f)	Dynamicrating	kA(peak)	
4.1.1.10	**VoltageTransformers**		
(a)	Type		
(b)	RatedVoltage (i)Primary	V	

Sr. No.	Description	Unit	TechnicalParticulars
	(ii)Secondary–S1	V	
(c)	Methodofconnection (i)Primary–P		
	(ii)Secondary–S1		
(d)	Application– S1		
(e)	Rated burden	VA	
(f)	Accuracyclass		
(g)	Ratedvoltagefactor (i)Continuous		
	(ii)Short time		
(h)	Insulationclass		
4.1.1.11 (a)	**Meters** Make		
(b)	AccuracyClass		
	(i)IndicatingMeters		
	(ii)EnergyMeter		
4.1.1.12	**ProtectiveRelays**		
(a)	Type		
(b)	Auxiliarysupply		
4.1.1.13	AnnunciationsProvidedasperPart12 - ParticularElectricalRequirementof Specification	Yes/ No	

Sr. No.	Description	Unit	TechnicalParticulars
4.1.1.14	Whether Cubicle Components ProvidedasperPart12- Particular Electrical Requirement of Specification	Yes/ No	
4.1.1.15	AuxiliaryA.C.SupplyVoltage&Frequency	V,Hz	

11 / 0.433kVTransformers

Sr. No.	Description	Unit	TechnicalParticulars
4.1.2.1	Make		
4.1.2.2	Type		
4.1.2.3	ApplicableStandards		
4.1.2.4	Rated output	kVA	
4.1.2.5	Quantityrequired	Nos.	
4.1.2.6	Transformerlocation		
4.1.2.7	Noloadtransformerratio	kV/kV	
4.1.2.8	Numberof phases		
4.1.2.9	Rated frequency	Hz	
4.1.2.10	Impedanceatall taps	%	
4.1.2.11	Noloadlossonprincipaltap	W	
4.1.2.12	Loadlossonprincipaltapand rated kVA	W	
4.1.2.13	Dimensions	mm	
4.1.2.14	Weight	Kg	
4.1.2.15	Numberofwinding/materialsof conductor/Insulation Class		

Sr. No.	Description	Unit	TechnicalParticulars	
4.1.2.16 (a) (b)	Methodofconnection HVwinding LV winding			
4.1.2.17	Vectorgroup			
4.1.2.18	LV Neutral			
4.1.2.19	Typeof cooling			
4.1.2.20	Tapchanger			
4.1.2.21	Taprange	%		
4.1.2.22	Tapstep	%		
4.1.2.23 (a) (b)	Terminalconnection HV terminals LV terminals			
4.1.2.24 (a) (b)	CurrentTransformer On LV OnLVNeutral			
4.1.2.25	LVNeutral earthing			
4.1.2.26	InsulationofWindings		H.V.	L.V.
(a)	One minute power frequency withstandvoltage(dryandwet)	kV (r.m.s)		
(b)	1.2/50microsecondfullwave impulse withstand voltage	kV (peak)		
4.1.2.27	Insulationofbushings		H.V.	L.V. (Lineand Neutral)
(a)	RatedVoltageofbushing	kV		
(b)	Oneminutepowerfrequency withstand voltage	kV (r.m.s)		

Sr. No.	Description	Unit	TechnicalParticulars	
(c)	1.2/50microsecondfull wave impulse withstand voltage	kV (peak)		
(d)	Minimumcreepagedistance	mm		
4.1.2.28	Vacuum withstand capability of transformermaintankwithbushings, radiations, fitting and accessories.			

415VMetalEnclosedSwitchgears(PCC)/MCC

Sr. No	Description	Unit	TechnicalParticulars
4.1.3.1	Make		
4.1.3.2	Type		
4.1.3.3	ApplicableStandards		
4.1.3.4	**415VSwitchgearandBusbar Ratings**		
(a)	Ratedvoltagephaseandfrequency		
(b)	SystemNeutral Earthing		
(c)	Maximumsystemvoltage	V	
(d)	Oneminutepowerfrequency voltage		
	i)Power circuits	V	
	ii)Controlcircuits	V	
	iii)Aux.Circuitsconnectedto Sec of CTS	V	
(e)	Continuous current rating of Busbars under site reference AmbientTemperatureandtype&material	Rating &Material	
(f)	Busbarinsulation		

Sr. No	Description		Unit	TechnicalParticulars
(g)	ReferenceAmbientTemperature		°C	
(h)	MaximumTemperatureofBusbars, Droppers and Contacts at Continuouscurrentratingundersite ambient temperature		°C	
(i)	ShortCircuitcurrentwithstand for Busbars and droppers (i)Shorttime1sec		kA(rms)	
	(ii)DynamicRating		kA(peak)	
4.1.3.5	**SwitchgearConstructional Requirement**			
(a)	Typeof Construction			
(b)	Thicknessofsheetsteel (i)Frame,Frameenclosures,doors, covers and partitions		mm	
(c)	Degreeof protection			
(d)	Colourfinish shade			
(e)	Earthingbus	Material		
		Size	mmxmm	
(f)	Earthingconductor	Material		
		Size	mmxmm	
(g)	Minimumclearancesinairofl ive parts (i)PhasetoPhase		mm	
	(ii)PhasetoEarth		mm	
(h)	Cableentryto cubicles			
4.1.3.6	**InstrumentationTransformers**			

Sr. No	Description	Unit	TechnicalParticulars
(a)	Currenttransformer		
	(i)Ratio		
	(ii)Burden	VA	
	(iii)AccuracyClass		
(b)	Voltagetransformer		
	(i)Ratio		
	(ii)Burden	VA	
	(iii)AccuracyClass		
4.1.3.7	AuxiliaryA.C.Supply		

415VPowerCapacitorandControlPanel

Sr. No	Description	Unit	TechnicalParticulars
4.1.4.1	**General**		
(a)	Make		
(b)	Type		
(c)	ApplicableStandards		
(d)	Rated Capacity	kVAR	
(e)	RatedSupplyVoltage	V	
(f)	Ratedfrequencyandphases		
(g)	ReferenceAmbienttemperature	^{o}C	
(h)	Cablegland required		
(i)	Typeof cable		
(j)	Sizeof cable		
(k)	Cableentry	Top/Bottom	
4.1.4.2	**ConstructionalRequirement**		
(a)	Thicknessofsheetsteel		

Sr. No	Description		Unit	TechnicalParticulars
	i)Frame,Frameenclosures,doors covers and partition		mm	
(b)	Degreeof protection			
(c)	Colourfinish shade		Interior Exterior	
(d)	Mainbusbarsandsize			
(e)	MaximumTemperatureofBusbars, Droppers and Contacts at Continuouscurrentratingundersite ambient temperature		°C	
(f)	Earthingbus	Material		
		Size	mmxmm	
(g)	Earthing conductor	Material		
		Size	mmxmm	
4.1.4.3	**Design Requirement**			
(a)	Insulationlevel		kV (rms)	
(b)	Capacitorbankconnection			
(c)	Shortcircuitwithstandforbusbars i)Shorttime(1sec)		kA(rms)	
	ii)Dynamic		kA(peak)	
(d)	Typeof switching			
(e)	Switchingsteps			
(f)	SwitchandRatingofcontactor			
(g)	IncomerMCCBcurrentrating			
(h)	O/Lcapacityof capacitors			
(i)	O/Vcapacityof capacitors			
(j)	Protections			

DieselStandbyGeneratorSet

Sr. No.	Description	Unit	TechnicalParticulars
4.1.5.1	**General**		
(a)	SetManufacturer		
(b)	Quantity&Type	Nos	
(c)	ApplicableStandard		
(d)	Rating	kVA	
(e)	Methodofstarting		
(f)	No.OfPhases,RatedVoltage, Frequency, PF and Speed		
(g)	Overloadcapacity		
(h)	ProvisionofAcousticenclosure		
(i)	ProvisionofAMFControlPanel for all the DG Sets	Yes/No	
4.1.5.2	**Alternator**		
(a)	Manufacturer		
(b)	Type		
(c)	ApplicableStandard		
(d)	Rating	kVA	
(e)	Voltage	V	
(f)	Numberof phases		
(g)	Frequency	Hz	
(h)	PowerFactor		

Sr. No.	Description	Unit	TechnicalParticulars
(i)	Rated Current	A	
(j)	OverloadCapacity		
(k)	Classof Insulation		
(l)	Degreeof protection		
(m)	WindingConnection		
(n)	Shortcircuitcurrent		
(o)	Typeofrotorbearings		
(q)	Provisionoftemperaturesensorsin stator windings		
(r)	**Exciter**		
(i)	Make		
(ii)	Type		
(iii)	ApplicableStandard		
(s)	**AVR**		
(i)	Make		
(ii)	Type		
(iii)	ApplicableStandard		
(t)	**Voltageregulation**		
(u)	**Outgoing Cable**		
(i)	Make		
(ii)	Type		
(iii)	ApplicableStandard		
(iv)	Size		

Sr. No.	Description	Unit	TechnicalParticulars
(v)	Windingmaterial		
(w)	Ratingofbiggestmotorwhichcan be started on DOL		
(x)	Detailsofprotection		
(y)	Efficiency		
4.1.5.3	**DieselEngine**		
(a)	Manufacturer		
(b)	Type		
(c)	ApplicableStandard		
(d)	Rating	HP/kW	
(e)	Speed	rpm	
(f)	Numberof Cylinders		
(g)	Numberof Strokes		
(h)	Typeof Starting		
(i)	Duty		
(j)	OverloadCapacity		
(k)	Radiator		
(i)	Make		
(ii)	Type		
(iii)	Fan power	kW	
(iv)	Coolingairflow		
(l)	**Exhaustsystem**		
(i)	Typeof Silencer		

Sr. No.	Description	Unit	TechnicalParticulars
(ii)	Exhausttemperaturegaugerange		
(m)	**Governor**		
(i)	Make		
(ii)	Type		
(iii)	ApplicableStandard		
(iv)	Classof governor		
(n)	**CoolingWater System**		
(i)	Watertemperature		
(ii)	WaterPressure		
(iii)	SystemCapacity		
(iv)	Provision of High water temperatureandlowwaterlevel switches		
(o)	**Lubricatingoilsystem**		
(i)	GradeofOil		
(ii)	OilPressure		
(iii)	Oiltemperature		
(iv)	SumpCapacity		
(v)	OilConsumptionper100hours		
(vi)	RecommendedtimeperiodofOil Change		
(p)	**Fuel**		
(i)	FuelSpecification		

Sr. No.	Description	Unit	TechnicalParticulars
(ii)	FuelConsumptionatratedCapacity		
(q)	**Dayoiltank**		
(i)	Capacity	Litres	
(ii)	ProvisionofLevelGauge		
(r)	Startingsystem		
(s)	Typeof cooling		
(t)	Exhaustsystem		
4.1.5.4	AMFControlPanel		
(i)	Make		
(ii)	Type		
(iii)	ApplicableStandard		
(iv)	ConstructionalFeatures		
(a)	Thicknessofsheetsteel Frame,Frameenclosures,doors covers and partition	mm	
(b)	Colourfinishshade -Interior		
(c)	Colourfinishshade -Exterior		
(d)	Degreeof Protection		
(v)	AMFFeaturesProvidedasper Technical Specification	Yes/No	
4.1.5.5	Protections,Alarm,Indications& Control whether provided as per Specification	Yes/No	
4.1.5.6	AcousticEnclosure		

Sr. No.	Description	Unit	TechnicalParticulars
(i)	Make		
(ii)	Type		
(iii)	ApplicableStandard		
(iv)	ConstructionalFeatures		
(a)	Thicknessofsheetsteel Frame,Frameenclosures,doors covers.	mm	
(b)	Degreeof Protection		
(c)	Acousticmaterial		
(iv)	Soundlevelat 1mdistance		
(v)	Whethercertifiedtomeetemission norms	Yes/No	
4.1.5.7	Battery		
(i)	Make		
(ii)	Type		
(iii)	ApplicableStandard		
(iv)	Voltage		
(v)	Capacityat10hoursrate		
(vi)	Numberofsuccessivestarting permissible		
4.1.5.8	BatteryCharger		
(i)	Make		
(ii)	Type		
(iii)	ApplicableStandard		

Sr. No.	Description	Unit	TechnicalParticulars
(iv)	ACInputtoCharger		
(v)	DCOutputof Charger		

VariableFrequencyDrives

Sr. No.	Description	Unit	TechnicalParticulars
4.1.6.1	**General**		
(a)	Make		
(b)	Type		
(c)	ApplicableStandard		
(d)	DriveApplication		
(e)	Quantity	No	
(f)	Typeof converters		
(g)	Invertercapacityatspecifiedpf		
(h)	Rated Current	A	
(i)	Loadpower factor		
(j)	Max.continuouscurrent	A	
(k)	Ratedvoltagewithnumberof phases	V	
(l)	Rated frequency	Hz	
(m)	ConverterBridge		
(n)	SingleQuadrant/ Twoquadrant/ Four Quadrant		
(o)	Typeof Duty		
(p)	DesignAmbientTemperature	^{0}C	
4.1.6.2	ControlCharacteristics		
(a)	Speed Control		
(b)	Rated speed	RPM	

Sr. No.	Description	Unit	TechnicalParticulars
(c)	Speed ratio		
(d)	Constanttorque/constant power		
(e)	Speed accuracy		
(f)	Closedloop/openloop		
(g)	Accel./Deccel.time		
(h)	PossibilityofRemoteOperation	Yes/ No	
4.1.6.3	OverallHarmonicLimitation	%	
4.1.6.4	Braking		
(a)	Typeof braking		
(b)	BrakingTorque		
4.1.6.5	Miscellaneous		
(a)	Soft-start	Yes/No	
(b)	Flyingrestart	Yes/No	
(c)	Auto restart	Yes/No	
(d)	KineticBuffering	Yes/No	
4.1.6.6	Confirm whether following minimumIndicationsonDrive Panel are Provided	Yes/No	
(a)	Motor running		
(b)	Motorstopped/ trip		
(c)	ACmains‘ON’		
(d)	SystemReadytostart		
(e)	VFDsystemfault		
4.1.6.7	ConfirmwhetherDigitalDisplayof following Minimum parameters on the Drive Panels:	Yes/No	

Sr. No.	Description	Unit	TechnicalParticulars
(a)	InputACVoltage		
(b)	InputACFrequency		
(c)	InputACCurrent		
(d)	OutputVoltage		
(e)	OutputCurrentVFD/Bypass		
(f)	OutputFrequency		
(g)	Motor speed		
(h)	Whether Necessary transducers providedforindicatingmotorspeed & current in PLC/DCS.	Yes/No	

Battery

Sr. No.	Description	Unit	TechnicalParticulars
4.1.7.1	Make		
4.1.7.2	Typeof battery		
4.1.7.3	ApplicableStandards		
4.1.7.4	Numberofbatterybanksrequired		
4.1.7.5	Ambientconditions	MinTemp& Max. Temp Deg C	
4.1.7.6	D.C.system voltage	V	
4.1.7.7	Amperehourcapacityofbatteryat 27 Deg. C at 5-hour rate to give final cell voltage of 1.16 volts/cell	Ah	
4.1.7.8	Momentaryload/duration	A	
4.1.7.9	Emergencyload/duration	A	
4.1.7.10	Continuousload/duration	A	

4.1.7.11	Nominalvoltage	V	
4.1.7.12	Cellvoltage-initial/final	V	
4.1.7.13	Dischargerate	Hours	
4.1.7.14	Numberofcellsperbankrequ ired to give rated voltage	Nos.	
4.1.17.15	Numberofsparecellsperbank	Nos.	
4.1.17.16	Overall dimensions		
4.1.7.16. 1	EachCell(LxWx H)	mm	
4.1.7.16. 2	Completebatteryinthe rack	mm	
4.1.7.17	Mountingarrangement		
4.1.7.18	Chargingmethod		

BatteryCharger

Sr. No.	Description	Unit	TechnicalParticulars
4.1.8.1	**General**		
(a)	Make		
(b)	ApplicableStandards		
(c)	Type		
(d)	Numberrequired	Nos.	
(e)	RatedOutputvoltage(DC)	V	
(f)	Rated Output	kW	
(g)	DCSystemEarthing		
(h)	Voltageregulationfromnoloadt o rated load	%	
(i)	ACrippleinDCoutputvoltagea t rated continuous load	%	
(j)	Typeof rectifier		
(k)	Transformer		
(l)	AmbientDesignTemperature	Deg.C	
(m)	Busbarmaterial& size	-	
(n)	Overall dimensions	mm	

Sr. No.	Description		Unit	TechnicalParticulars
4.1.8.2	**BatteryDetails**			
(a)	Float/Tricklechargingcurrent of battery		mA	
(b)	BoostChargingCurrentofBattery (Maximum)		A	
(c)	BoostChargingVoltageofBattery (maximum)		V	
(d)	MaximumTimeforBoostcharging of Battery		hr	
(e)	Batterycapacity&no.ofcells		Ah	
			Nos.	
4.1.8.3	**ACSystemData**			
(a)	Supply	Voltage	V	
		Phase		
(b)	(i)VariationinsupplyVoltage		%	
	(ii)Variationinsupplyfrequency		%	
(c)	ShortCircuitlevel		kA	
(d)	Typeof earthing			
4.1.8.4	**Performance**			
(a)	DCvoltagesettingadjustment for floatcharger			
(b)	Voltagestabilisationforconstant voltageregulator			
(c)	Maximumpermissiblevariation inDCvoltage(noloadtofullload)			
(d)	D.C.voltagesettingadjustment forboostcharging			
(e)	D.C.currentadjustmentforboost Charging			
(f)	Currentstabilisationforconstant			

Sr. No.	Description		Unit	TechnicalParticulars
	currentregulatorforboostcharger			
(g)	Minimumpermissiblepowerfactor toratedcontinuous load			
(h)	Permissibleripplecontentatrated continuousload			
(i)	Relay for auto changeover from Float to boost mode to be provided (incaseoffloat-cum-boostcharger)			
4.1.8.5	**ConstructionalFeatures**			
(a)	Thickness of sheet steel Frame, Frameenclosures,doors,coversand partition		mm	
(b)	Degreeof protection			
(c)	Colourfinish shade			
(d)	Busbarmaterial& size			
(e)	Earthingbus	Material		
		Size	mmxmm	
(f)	Earthingconductor	Material		
		Size	mmxmm	
(g)	Cableentry			
(h)	Cable Sizes (i)Battery		sq.mm	
	(ii)DC output		sq.mm	
	(iii)ACinput		sq.mm	

DCDistributionBoard

Sr. No.	Description	Unit	TechnicalParticulars
4.1.9.1	**General**		
(a)	Make		
(b)	Applicablestandards		
(c)	DCSystemvoltage(Nominal)	V	

4.1.9.2	DCSystemEarthing			
4.1.9.3	AmbientDesignTemperature		Deg.C	
4.1.9.4	Busbarmaterial,ratingandsize			
4.1.9.5	**DCBus Load**			
(a)	TotalcontinuousDCload		A	
(b)	Shorttimeloads(Additionalto continuousloads)			
	(i)DClights/Facia lamps		A	
	(ii)Startingcurrentand duration ofLargestConnectedDC Motor		A	
4.1.9.6	**ConstructionalFeatures**			
(a)	Thickness of sheet steel Frame, Frameenclosures,doors,cover sand partition		mm	
(b)	Degreeof protection			
(c)	Colourfinish shade			
(d)	Earthingbus	Material		
		Size	mmxmm	
(e)	Earthingconductor	Material		
		Size	mmxmm	
(f)	Cableentry			
(g)	Cable Sizes (i)DCInput fromBattery		sq.mm	
	(ii)DCoutputtoLoad		sq.mm	

Non-SegregatedBusDuct

Sr. No.	Description	Unit	TechnicalParticulars
4.1.10.1	TypeofBusDuct		
4.1.10.2	Typeof Cooling		
4.1.10.3	Installation		

Sr. No.	Description	Unit	TechnicalParticulars
4.1.10.4	NominalServiceVoltage	V	
4.1.10.5	RatedVoltageClass	V	
4.1.10.6	ContinuousCurrentRatingofBus Ducts under Site Conditions	A	
4.1.10.7	One-minutePowerFrequency Withstand Voltage	V	
4.1.10.8	MomentaryCurrentRating	kA	
4.1.10.9	ShortTimeCurrentRatingforone second - kA (RMS)	kA	
4.1.10.10	MaximumTemperature(Hot Spot) of Busbars at Rated Current	˚C	
4.1.10.11	MaximumTemperature(Hot Spot) of Enclosure at Rated Current	˚C	
4.1.10.12	BusbarMaterial		
4.1.10.13	BusbarSection		
4.1.10.14	BusEnclosure Material		
4.1.10.15	ThicknessoftheEnclosure	mm	
4.1.10.16	ShapeofEnclosure		
4.1.10.17	PhaseClearance(Minimum) Phase to Phase Phaseto Earth	mm mm	
4.1.10.18	TypeofJointsbetweenAdjacent Sections of Bus Conductor Welded/Bolted		

Cables

Sr. No.	Description	Unit	TechnicalParticulars
4.1.11.1	**11kV(UE)XLPEInsulatedPower Cables**		
(a)	Make		
(b)	Type		
(c)	ApplicableStandards		
(d)	Cablesizeselectionwhetherdoneas per Specification	Yes/No	
(e)	Continuouscurrentratingwithcable laid in air/ground under specified ambient temperature	A	
(f)	Conductormaterial		
(g)	Conductorscreening		
(h)	Insulation		
(i)	ScreeningonInsulation		
(j)	Identificationofcodes		
(k)	Innersheath		
(l)	Filler material		
(m)	Armouring		
(n)	Outersheath		
(o)	Overalldiameterofcable	mm	
(p)	Recommendedminimumbending radius	mm	
(q)	Standardlengthofcableoneach drum	Mtr.	

Sr. No.	Description	Unit	TechnicalParticulars
4.1.11.2	**1100VGradeXLPEInsulated Power Cables**		
(a)	Make		
(b)	Type		
(c)	ApplicableStandards		
(d)	Cablesizeselectionwhetherdoneas per Specification	Yes/No	
(e)	Conductormaterial		
(f)	Insulation		
(g)	Innersheath		
(h)	Armouring		
(i)	Outersheath		
(j)	Overalldiameterofcable		
(k)	Recommendedminimumbending radius	mm	
(l)	Standardlengthofcableon each drum	Mtr.	
4.1.11.3	**650/1100VGradePVCInsulated Control Cables**		
(a)	Make		
(b)	Type		
(c)	ApplicableStandards		
(d)	Conductormaterial		
(e)	Insulation		

Sr. No.	Description	Unit	TechnicalParticulars
(f)	Innersheath		
(g)	Armouring		
(h)	Outersheath		
(i)	Standardlengthofcableoneach drum	Mtr.	

LightingFixturesandAccessories

Sr. No.	Description	Unit	TechnicalParticulars
4.1.12.1	**General**		
(a)	Illumination levels at various premiseswhetherconsidered asper Specification	Yes/No	
(b)	Normalsupplyvoltage,phaseand frequency	AC	
		DC	
(c)	Variationinsupply:		
	(i) Voltage(AC&DC)	%	
	(ii) Frequency	%	
	(iii)Combinedvoltage&frequency	%	
(d)	Designambientairtemperature	^{0} C	
4.1.12.2	Luminaireterminalsuitablefor		
(a)	Indoor area		
	(i)Conductor material		
	(ii)Cablesize	Coresx mm^2	
(b)	Outdoorarea		
	(i)Conductor material		
	(ii)Cablesize	Coresx mm^2	
4.1.12.3	Luminaireearthingterminalsuitable for		

Sr. No.	Description	Unit	TechnicalParticulars
	(i)Conductor material		
	(ii)Conductor size	SWG	
4.1.12.4	Luminaires		
(i)	LEDLuminaires		
(a)	Make		
(b)	Type		
(c)	Rating		
(ii)	High/Medium/LowBayLED Luminaires		
(a)	Make		
(b)	Type		
(c)	Rating		
(iii)	FloodLightLEDLuminaires		
(a)	Make		
(b)	Type		
(c)	Rating		

LightingSystemandEquipment

Sr. No.	Description	Unit	TechnicalParticulars
4.1.13.1	**SystemParticular**		
(a)	**Voltage**		
	(i)3Phase,4wire50Hzsystem		
	• Rated	V	
	• Maximum	V	
	• Oneminutewithst and voltage		
	(ii)D.C.system		
	• Rated	V	
(b)	Systemshort-circuitlevel		

Sr. No.	Description	Unit	TechnicalParticulars
	(i)At415V,A.C.	kA(rms)	
	(ii)At110V, D.C.	kA(D.C.)	
(c)	Referenceambienttemperature	^{0}C	
4.1.13.2	**DistributionBoard/Panels**		
(a)	Main,floormounteddistributi on boards		
(i)	MainLightingdistributionboa rd (A.C.)		
	• Make		
	• Type		
	• Degreeof protection		
	• Busbar material		
	• Busbarcurrent rating	A	
	• Shortcircuitcurrentratin g	kA	
	• DetailsofIncoming and Outgoing feeders		
	• Cableentry		
	• Location		
(ii)	Emergencylightingpanel(D.C.)		
	• Make		
	• Type		
	• Degreeof protection		
	• Busbar material		
	• Busbarcurrent rating	A	
	• Shortcircuitcurrentratin g	kA	
	• DetailsofIncoming and Outgoing feeders		
	• Cableentry		
	• Location		
(iii)	SinglephaseDBs, wall/structure		

Sr. No.	Description	Unit	TechnicalParticulars
	mounting		
	SLDBforindoorarea		
	• Make		
	• Type		
	• DetailsofIncoming and Outgoing feeders		
	• Degreeof Protection		
(iv)	SLDBforoutdoorarea		
	• Make		
	• Type		
	• DetailsofIncoming and Outgoing feeders		
	• Degreeof Protection		
(v)	Paint Finish		
	(ii)Colourshade:		
4.1.13.3 (a)	**StreetLightPolesandFloodLight Poles** StreetLightPole		
	Type		
	TotalHeight:	Mtr.	
	Quantity:	Nos.	
(b)	FloodlightLight Pole		
	Type		
	TotalHeight:	Mtr.	
	Quantity:	Nos.	
	No.Offloodlightstobefixedper pole	Nos.	

EarthingandLightningProtectionSystem

Sr. No.	Description	TechnicalParticulars		
		Size	**Material**	**No. of Leads &Quantity**
4.1.14.1 (a)	**MainEarthingGrid** Buriedinearth			
(b)	Buriedinfloorslabsinbuildings			
4.1.14.2	**ConductorLeadsto Equipment** (above ground)			
(a)	Transformers			
(i)	Transformerneutraltobottomof tank			
(ii)	Frombottomoftanktoearth grid			
(iii)	Transformertanksandradiator bank			
(b)	DieselGeneratorSet			
(i)	DGSetneutralearthing			
(ii)	DGSet bodyearthing			
(c)	Fencepostsandgates(Flex. braid)			
4.1.14.3	11kV Metal Enclosed Switchboard,415Vswitchgear/ MCC.			
4.1.14.4	Motors			
(a)	415VMotorsabove10kW			

Sr. No.	Description	TechnicalParticulars		
(b)	415VMotorsupto10 kW			
(c)	Fractionalhorsepowermotors			
4.1.14.5	**OtherItems**			
(a)	Capacitor panel, Battery charger panel, DC distribution board, MainlightingD.B,Controlpanels and sub-lighting distribution boards			
(b)	Hand Rails			
(c)	Cabletrays			
(d)	Tanks			
(e)	Junctionboxes			
(f)	Lightingfixtures,receptacles, lighting conduits			
(g)	Pushbuttonstations,limit switches			
4.1.14.6	**Cranerail**			
4.1.14.7	Streetlighting,floodlighting poles and junctions boxes			
4.1.14.8	Metallicnon-currentcarrying structures			
4.1.14.9	**LightningConductors**			
(a)	Lightningprotectiondowncomers for building			
(b)	Lightningprotectionhorizontal roof conductor for building			

Sr. No.	Description	TechnicalParticulars		
4.1.14.10	**Electrodes**			
(a)	Pipeelectrode			

Endof Schedule-IV

PART1

PROJECTDETAILS

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PART-1

PROJECTDETAILS

Backgroundtothe Project

The flow from ward 174 is at present flowing in the existing sewer network, however due to insufficient carrying capacity of the sewers, the sewers either overflows on the road or in the adjacent drain.Thusagravitysewerofdiameter300and900mmRCCNP3pipefromIAS OfficersColonytill the 35.0 MLD AGARAM STP, HSR Layout is proposed.

WorksDetailsforContract Package

Theproposedsystemunderthis Contractconsistsofconstructionofintermediatesewagepumping stations (ISPSs) with pumping mains, and ISPS with pumping main shall be on a Design Build Operate basis under appropriate Conditions of Contract.

ComponentListforWorks

Followingtableshowsthedesignflowcapacities

S. No.	Zone	ISPSName	UltimateFlows (MLD)		
			InitialDesign @Year2025	Intermediate Design@year 2040	Ultimate Design@Year 2055
1	K&TValley	ISPSat35.0MLD AGARAM STP, HSRLayout	11.5	13	14.5

TheISPSshallbedesigned&constructedfortheyear2055flows(civilworks)exceptthatthenumber of pumps and its mechanical/electrical equipment which shall be provided for the year 2040 flows.

ScopeofWork

TheScopeofWorkunderthiscontractincludesbutisnot limitedtothefollowinginrelationtothe design, build (construction) and operation and maintenance of the Works, which are to be implemented under Works:

- All preparatory work including clearing and leveling of site, site grading, formation of FinishedGroundLevel(FGL),constructionofinternalroads,allaroundcompound walletc.,excavation,

dewatering as required and disposal of all surplus earth to a suitable location as specified/directed by Engineer.

- Topographicalsurvey,geotechnicalinvestigation,andanyotherinvestigationcomplete .
- All existingfacilities intheallocated areathat are to be demolished to accommodate ISPS shall be properly de-commissioned, removed, stacked and appropriately disposed of by the Contractorafter getting the approval on its Salvage value as directed by Engineer.
- Demolishing shall be carried out in accordance with all applicable laws, regulations, andstandards. Items, components, or materials, whether buried, exposed, submerged, or otherwise, shall not be abandoned or left on site unless explicitly specified.
- Preparation of hydraulic designs with layout, process flow diagram, piping and instrumentation diagram, mass balance and hydraulic flow diagram of the complete ISPS & Pumping main (PM)as stipulated in scope.
- PreparationofGADrawings,UnitProcess/Equipment/Facility/ Buildinglayouts,etccomplete.
- Detailed sizing, design, and engineering, of all treatment units, buildings, structures, and equipment (including all civil, mechanical, electrical, architectural, instrumentation, control, automation, and SCADA components).
- Submission of detailed engineering designs, drawings, calculations, and data sheets as per requirements of Bidding Document.
- Design, construction, testing and commissioning of all civil structures, building works, bypass lines and other pipelines complete.
- Design, construction, testing and commissioning of all allied pumping mains, bypass lines and other pipelines complete
- Procurement, supply, installation, erection, testing and commissioning of all mechanical,electrical, instrumentation, PLC/SCADA system complete.
- Design, construction, and commissioning of all pipelines, flow meters, channels, outfall structure for the disposal of plant effluent from chlorine contact tank to nearby water body at each site complete.
- Design and construction, of approach road, all internal plant roads & internal storm water drains, curbs, pavements, parking spaces, compound wall, retaining walls, culverts, nalla diversion works complete.
- Interconnectionswithotherworksasrequiredcomplete.
- Planttesting,commissioning,stabilization,demonstrationofperformanceguarantee.
- SubmissionofOperationandMaintenanceManuals.
- ProvidingtrainingservicestoEmployer’spersonnelincludingO&Mstaff.
- Completeplantationandlandscapingworkstogivepleasantenvironmentofbuildout campus.
- PreparationandsubmissionofAs-Builtdrawingsforallcivil,mechanical,electrical, Instrumentation, SCADA works complete.
- PLCbasedSCADAsystemforfullyautomatic&safeoperationofISPS.
- Wireless Communication System for remote monitoring of ISPS from Central SCADA Station at Shimsha Bhavan / Cauvery Bhavan as well as wireless

communication between ISPS PLC & STP SCADA.

- AuxiliarysystemslikeCCTVmonitoringofISPS.

- Five (5) years Operation and Maintenance for all ISPS in this Contract after successful passing of the Tests on Completion of Design-Build and Issue of the Commissioning Certificate as per the Conditions of Contract given in Volume1 of the Bidding Document.
- Overflowfromunitsshallbetothenearby SWD.
- Handingoverthe facilities.

Notes:

1)Contractor to submit Unit Process / Equipment / Facility / Building wise Construction Approach and Methodology, prior to start of each/any type of constructional activity at site.

AdditionalScopeDetails forCivil Works

ThescopeofworkforISPS&pumpingmainshallincludeallcivilworksasper processrequirements, including other facilities as listed below.

GeneralpointstobenotedandimplementedforISPS

1. ApproachRoadswithgatesshallbeprovidedforallISPSs sites.
2. Plant internal roads shall be at least 3.5 m wide with one side RCC drain. Additionally, 1.50m shoulder shall be provided for future expansion.
3. Parking sheds in Steel Structure with RCC foundation pedestal and corrugated MS sheets for roof of not less than 50 Sqm shall be provided.
4. The undulated ground shall be properly graded up to the site FGL for all the ISPS sites. The FGL shall be 1.0m above the HFL for all sites.
5. HFL provided in this document is for the guidance. Further the same shall be ascertained during execution by confirmatory Geotechnical report, as per site requirement and shallget approved from the Engineer incharge.
6. The ISPS sites shall have approach road of 5m width from available road running in front of the gate.
7. Theinformation provided in this document are onlythe minimumrequirements atthe site. ThecontractorshallvisitthesiteandBidaspertheactualsiterequirements.No additional claim or variation shall be allowed in case, if there is any change in minimumrequirement.
8. TheHFL,FGLandEGLprovidedbelowaretobefieldverifiedbythe Bidders.
9. 450mm thick Stone soling shall be provided for all buildings and minor structure foundations below PCC to improve the strength of the soil.
10. All trees, vegetation shall be removed after obtaining necessary permissions from the concerned authority and instructions of Engineer in Charge.

ScopeofworksforISPS

1. Wet-well, inlet chamber, screen chamber, effluent channel etc.., associated with Wet well shall be constructed by Well sinking method/any other method approved by BWSSB.

2. Chainlinkfencingofminimumlength160mshallbeprovidedallroundthepro posedISPS for a minimum height of 2.1m.
3. TheHFLofthesiteis + m.
4. TheFGLofsiteis+878.0m.
5. Approachroadminlengthof150m

1. **PumpingMain:**

Pumpingmainofminimum600mmdia,DI-K9foralengthofminimum150 mwithallrequiredair/ scour and safety valves to be laid in all types of soil including rock including surge protection arrangements. All necessary items are included and not limited to items specified in price bid.

FundingAgencyandFinancing

FundsfortheContractarebeingGOK&BWSSB.

Site Conditions

EachPlantshallbedesignedandconstructedtakingintoaccountthefollowing:

AnnualAverageAmbientTemperature	:	27°C(Minimum15°C-Maximum45°C)
RelativeHumidity(maximum)	:	75 %
SiteConditions	:	Tropical

The plant shall be designed to suit the ambient temperature mentioned above with the Contractor makingdueallowanceinhisdesignsfortheincreasedtemperaturesexperiencedbyPlantexposedto direct sunlight.

MinimumDesignLife

ThePlantcomponentsshallbedesignedandconstructedtoprovidetheminimumservicelifelisted below for each component.

ReinforcedConcreteStructures	:	60 Years
BuriedPiping	:	60 Years
OtherCivilStructures	:	50 Years
SteelStructures	:	50 Years
BuriedEarthElectrodeSystem	:	40 Years
MechanicalEquipment	:	20 Years
ElectricalEquipment	:	15 Years
ControlPanels	:	15 Years
InstrumentationSystems	:	10 Years
Diffusers	:	7 Years
ComputerSystem	:	7 Years
AlltypeofServerandComputerbased Software’s	:	Shouldbeupdatedtolatest version

AccessforOther Contractors

The Contractor shall allow reasonable access to other Contractors engaged on the Site or on areas adjoining the Site to carry out their work. In the event of a dispute over access or priority between Contractors,theEngineershallbeinformedinwriting.TheEngineershallinformallparties concerned in writing of his decision.

Where any part of the Works is associated with or in physical contact with plant supplied under a separatecontract,theContractorshallsatisfyhimselfthattheworkcarriedoutbytheotherContractor is consistent with the correct operation of the Plant. In the event of the Contractor considering any work being carried out or any work already completed to be detrimental to the ultimate operation of the Plant, he shall report the matter to the Engineer.

IftheworkoftheContractorisdelayedbecauseofanyactsoromissionsofanyothercontractor,the Contractor shall have no claim against the Employer on that account other than for an extension of time.

SurveyandGeotechnicalData

Contractorshallcarryoutindependentlyfreshsurvey,geotechnicalinvestigationand allotherdetails necessary for proper planning, detailed design and execution of all works under this Contract. The Contractor will be required to provide full details of the survey and geotechnical investigations of works for approval of the Employer. Reference drawings are available with Engineering In charge

Contractor’sBangaloreSatelliteOffice

Contractor shall designate an Engineering Manager (Lead design and Technical Support) who is responsibleforthecompleteWorksdesignincludingpreparationofDetailedDesignsandobtainingall required Detailed Design approvals.The Contractor shallalso designate Design Leadsforeachdesign discipline required. The Contractor shall mobilize the entire Design Team to a Satellite Office in Bangalore. This design office shall be in addition to its Construction Site Office.

The Satellite Office shall be staffed to facilitate and expedite submittals of Detailed Designs. Contractor shall designate a Deputy Design Manager who reports directly to the Contractor’s Engineering Manager and will be stationed full-time in the Bangalore Satellite Office through the Detailed Design preparation, submittal and approvals. Contractor shall also designate Design Leads for each design discipline required stationed in the Bangalore Satellite Office who will do design production. The Deputy Design Manager and Design Leads will communicate directly with Employer’s staff and its designees throughout Detailed Design preparation, submittal, review and approval,aswellasduringthesameproceduresforsubmittalsfortestingandcommissi

oningandall other design related submittal required inaccordance withthe Contract.The Satellite Office Staff in conjunction with the Contractor’s Home office staff will be responsible for timely response to Employer’s comments related to the Detailed Design.

The Contractor’s Engineering Manager will be responsible for the efficient coordination of the SatelliteOffice,HomeOfficeandEmployer’sstaff&itsdesigneessuchthatthedesignworkproceeds expeditiously.

The Contractor shall operate and maintain its Satellite Office throughout the Detailed Design preparation,submittalandapprovalprocess.ApprovaloftheDetailedDesignshall bedetermined when all submittals have received a review designation of “A-Approved” and final copies of all Detailed Designs have been submitted.

Battery Limits between Works The following are the Battery Limits (interfacesbetween) Works - for the following cases:

PumpingmaintoSTPorGravitysewerto ISPS
The interface between Works of gravitysewer and ISPS shall be the downstreamof the manhole outsideoftheISPSlocationandthePumpingmainshalldischargeintotheinletofSTPSiteoras shown byEngineeringin charge. The terminal manhole shall be located suchthat the edge of the manhole is located minimum 2 m from the centre of the fence or wall.

ConnectionsofProposedPumpingMainstoExistingManholes
ConnectionsshallbemadeasdescribedforConnectionsofProposedSewerstoExistingManholes.

InterfacewithOther Contracts

TheContractorforthiscontractshallco-ordinatewithEmployerandtheContractorsfortheabove Contract as applicable and ensure that all interfaces are designed, constructed, installed, tested, commissioned,operated, and maintained properlyto provide a fullyfunctional system meetingall applicable performance requirements.

TheContractorforthisContractshall befullyresponsibleforindependentlyfield-verifyinganyandall information he considers relevant in order to provide a fully functional system.

SectionalCompletionofWorks

Sectional Completion of Works is required by the Employer and is included in Volume 1 of the BiddingDocument.TheContractorshallinparticularnotetheimportanceandsequenceofSectional Completion considering also the interface between existing facilities and those being implemented under a separate Contract.

The Contractor should note that the lateral sewers which discharge sewage to

the ISPS to be implementedunderthisContractarebeingimplementedunderaseparatecontract,whichiseitherin progress or completed. The Contractor shall familiarize himself with the schedule for the above Contract and monitor the progress on a regular basis.

IntheeventthatconstructionoftheISPSiscompletedbeforewastewaterisavailableataISPS,the Contractor shall properly maintain the ISPS inaninactivestateuntilsuchtimeaswastewaterbecomesavailable.Further,alltheco mponentsofthe plant shall be adequately secured, protected, maintained, and exercised according to manufacturers' instructions during this inactive period. This inactive period shall be considered part of the Operation and Maintenance Period.

ThemonthlypriceformaintainingeachISPSinthiscontractinaninactivestateshallbed ecidedby mutual agreement between the Employer and the Contractor as necessary.

Specified activities related to commissioning, testing, demonstration of performance shall be performedwhenwastewaterbecomesavailableattheISPS.Noadditionalpaymentsh allbemadeto the Contractor for such deferred activities

EndofPart1

PART2

THESITE

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PART2

THESITE

Locationofthe Sites

Thelocationoftheworksisasindicatedbelow:anddetailsofsitelocationareshownondrawings

TheproposedIntermediateSewagePumpingStation(ISPS)isatExisting35MLDAgaramSTPcampus.

AccesstotheSites

TheEmployerwillaffordtotheContractoraccesstoandpossessionoftheSiteforcarryingoutthe Works.The Contractorshall be deemed to haveinspected the ISPS , pumping main sitesincluding access before submitting his Bid.

ThemainaccesstotheproposedsiteisOuter RingRoad,14thHSRLayout.

AreasoutsidetheSite

IntheeventoftheContractormakinguseofanyspecialortemporarywayleaveoraccommodationacquiredbyhimoranytipforthedisposalofsurplusmaterials,oranyborrow pitorquarry,heshallobtainthewrittenconsentoftheowner,occupierorauthorityhaving chargeofthelandinwhichsuchwayleave,accommodationortipissituatedandshallmakea recordagreedbytheowner,occupierorauthorityasaforesaidoftheconditionofthesurfaceof that land before entering thereon.

TheContractorshallpermittheEmployerandtheEngineerandanypersonauthorisedbythe Employer or the Engineer access for the purposes of the Contract to any such special or temporary wayleave or additional accommodation.

IntheeventoftheContractormakinguseofanyspecialortemporarywayleaveoradditional accommodation made available to him by the Employer for the purpose of the Contract, the land in which such wayleave or accommodation is situated shall be deemed to be part of the site.

The Contractor shall restrict his activities to within the working area to be approved by the EngineeraftertheContractorsubmitstheproposalfor thesame.Oncompletionoftheworks

inthisarea,theContractorshallreinstatetheareatoitsoriginalconditiontothes atisfactionof the Engineer.

ForthepurposesofthisClause,`accommodation'shallbedeemedtoinclude housing, offices, workshops, warehouses, and storage areas.

Road Works

The Contractor shall obtain the Engineer’s permission for carrying out works such as excavation on the existing roads. The Contractor shall be responsible for establishing and maintainingtemporaryroaddiversions for the durationof the road works. The road shall be keptopenatalltimesduringtheroadworksperiodandtheworkshallbecarried outinsuch a manner as to minimize the disruption to execution of other Contractor’s works.

.

MaintenanceofExistingAccessRoads

The Contractor shall only use existing access roads within the Site boundary which are necessary for the execution of the Works. The Contractor shall obtain the Engineer's approval in writing before utilising existing access roads within the Site. Once the Engineer's approval has been given the Contractor shall be solely responsible for the maintenance of the existing site access roads. This responsibility shall continue until the completion of the Defects Notification Period, or until such earlier date as the Engineer may advise the Contractor in writing. Such maintenance work shall include general up-keep and any necessary repairs to damaged road surfaces, pavement, drainage, associated slopes, etc. to a standard at least equal to their original condition. While carrying out such maintenance work, the Contractor shall make arrangements to maintain through passage for the Employer's and his staff's vehicles and also those of other contractors over these access roads. Such arrangementsmaycomprisetemporarydiversions,alltotheapprovalandsatisfaction oftheEngineer.

The Contractor shall not run tracked or upsprung vehicles on surfaced roads without the written approvaloftheEngineerwhomayrequirethatplankingorsomeotherprotectivemateri albeusedto protect the road surface.

Clearanceof theSite

TheContractorshallclear theSitetotheextentrequiredbytheEngineerforcheckingthesett
ing-out.

ClearanceoftheSiteshallalsoincludedemolitionandremovalofallarticles,objectsand obstructions which are expressly required to be cleared.

TheContractorshallensurethatthepartsoftheSitetobeoccupiedbythePermanentWo rksareclear,
andshallmaintaintheremainderoftheSiteasmayberequiredforaccessandtemporar yworks areas.

TheContractorshallremovethematerialarisingfromsuchclearanceanddisposeofit inamanner and at a location that are both in compliance with all applicable laws and regulations.

TheContractorshallbackfillwithappropriatespecifiedmaterialsandproceduresth osecavitiesand
lossesofsoilwhichresultfromclearingthepartsoftheSitenotsubsequentlytobeocc upiedbythe Works.

TheContractorshallnotcleartheSiteofanyexistingstructure(s)withoutthepriorwritt eninstruction of the Engineer.

ClearanceandReinstatementoftheSiteonCompletion of theWorks

On completion of the Works, the Contractor shall clear any temporary works areas and temporary accessroadsandreinstatetheareastotheiroriginalconditionandtothesatisfactiono fthe Engineer.

AccessfortheEmployerand Engineer

The Contractor shall permit the Employer and the Engineer and any person authorised by the Employer or the Engineer including workmen of the Employer, other Contractors or utility undertakingsaccessforthepurposesoftheContracttoallareasoftheSiteandtoany additional accommodation or temporary way leave for the duration of the Contract period.

Site Records

TheContractorshallmake recordsofthepositionandextentintheexcavationsofeverytypeof service, stratum and obstruction encountered during the construction of the Works.

AccessfortheEmployerand Engineers

The Contractor shall permit the Employer and the Engineer and any person authorised by the Employer or the Engineer including workmen of the Employer, other contractors or utility undertakingsaccessforthepurposesoftheContracttoallareasoftheSiteandtoany additional accommodation or temporary wayleave for the duration of the Contract period

PermissionfromService Agencies

The Contractor, who is the sole responsible to get the necessary permission from service agencies, such as, BBMP, BDA, Traffic Police, KPTCL, etc. the delay in getting the permission will not be takenintoaccount.ThecontractorshallobtaintheEngineer’spermissionforcarrying outtheworks such as, excavation on the existing roads, Employer will assist contractor to issuing the letter to the concerned department, if necessary.

.

CampFacilities

The Contractor shall construct and maintain to the Engineer’s satisfaction a camp to provide living accommodationforallContractorsstaffandoperativeswhohavenootherlocalaccommodat ion.The Contractor's camp shallbe located close tobut not on the Siteitself andata location approved bythe Engineer.

Responsibilityforprovidingallservicestothelivingquartersandcompliancewithalls anitarylaws and other laws and regulations shall be borne by the Contractor. Security and the fencing of these areas shall be the responsibility of the Contractor.

CompressedAirUseonSite

TheContractorshallprovidethenecessarycompressedairplantandequipmentrequir edfor construction of the Works.

Electrically driven compressors connected to the site electricity supply shall not be used. Diesel enginedrivencompressorsshallnotbesitedwithinbuildingsorinalocationthatmayca

useahealth hazard to personnel owing to exhaust fumes or noise.

RefuseDisposal onSite

Refuse and rubbish of every kind shall be removed fromthe Site and disposed of bythe Contractor at hisownexpense,frequentlyandregularlyat aminimumperiodofoneweeksoastokeeptheSiteina wholesome and tidy condition to the satisfaction of the Engineer.

SafetyandSecurityon Site

TheContractorshallatalltimesmaintainsafeworkmethodsandproceduresandshall complywith all enactments, regulations and working rules relating to safety, security, health and welfare of all persons who may be affected by his work.

Inparticularheshallensurethatonlypersonswhoareproperlytrainedfortheirdutiesa reemployed, and that appropriate, approved tools, safety equipment, and procedures are used.

NothingwhichhasbeenwrittenintooromittedfromtheEmployer'sRequirementssh all betakento relieve the Contractor from his obligations under this clause. No clause in the Employer's Requirements shall preventthe Contractorfromdrawingthe attention ofthe Engineerto anyfeature of the Works which is not consistent with normal safety practices nor prevent him from putting forward proposals at any time which would increase the safety of the installations.

Not later than four weeks before work commences on the Site, the Contractor shall submit to the Engineerhiscomprehensiveplansandproposalsrelatingtotheallaspectsofhealthand safetyonthe Site. The proposals shall be appropriate for all grades of labour and personnel who will work on or visit the Site on behalf of the Employer, Engineer or Contractor.

TheContractor shallappoint **Health& Safety Engineers(AccidentPreventionOfficers**), whoshall beresponsiblefortheimplementationofsiteproceduresasperrelevantstandards.The responsibilities of the above engineers shall include but not be limited to:

- safety;
- workinginhazardousareas;
- permittowork;
- fireandsmokingregulations;
- firstaid;
- warningsigns;
- trenchingscaffoldingandotherconstructionstructures;
- safetybarriers;
- protectiveclothingandequipment;
- safetytraining;
- safetymeetingsandinspections;
- healthand welfare.

TheEngineershall havethepowertostopanyactivityorworkinanyareawherethereisabreachof the published site safety rules or health and safety is otherwise endangered.

The Contractor shall ensure that all other Contractors working on the Site also follow established healthandsafetyprocedures.TheContractorshallbringanyviolationofSitesafetyrulesbyothersto the attention of the Engineer in writing.

First Aidand Life-savingApparatusonSite

The Contractor shall provide on the Site such life-saving apparatus as may be appropriate and an adequate and easily accessible to workmen and all other Staff a first aid outfit/station or such outfits/station as may be required in any government ordinances, factories acts, etc, published and subsequently amended from time to time. Each station shall be properly equipped and shall be under the charge of a suitably qualified and trained staff member. In addition, an adequate number of personspermanentlyontheSiteshallbeinstructedintheiruse,andthepersonssodesignatedshall be made known to all employees by the posting of their names and designations in a prominent position (positions) on Site.

TheContractorshallarrangeformedicalservicestobepromptlyavailablewhennecessaryandshall also provide for transport of serious cases to the nearest hospital. These and all other arrangements shall be included in the Contractor’s Safety Plan.

ElectricalSafetyonSite

The Contractor shall be responsible for the electrical safety of all Plant and equipment supplied and installed. Whilst any equipment is being installed or tested, the Contractor shall ensure that all necessaryprecautionsaretakentosafeguardpersonnelworkingonsite.Ifnecessary,this shallinclude fencing off areas which are considered to pose a risk, and erecting warning notices.

TheContractorshallberesponsibleforensuringthattheelectricalinstallationiscarriedoutby suitably trained competent personnel and that the work is carried out in a safe manner.

TheContractorshallberesponsiblefortheoperationontheSiteofapermit toworksystemduringthe period of electrical equipment installation and testing. This system shall regulate the installation, the energisation and the use of electrical Plant and equipment installed and the method of work adopted.

Noise

TheContractorshallensurethattheoperationsentailedintheconstructionoftheWorksdonotcause annoyance to others working on the Site or to persons living adjacent to the Site.

Warning andSafety Signs

During construction of the Works statutory safety signs shall be adequately provided throughout the Works, both indoors and outdoors. These safety signs shall cover mandatory, prohibition, warning, emergency,fire-fightingandgeneralnotices.AllsignsshallbepositionedaroundtheWorksathighly visible points. Provision ofsigns andthepositionsof signs shall besubject totheEngineersapproval. Special attention shall be given to areas designated hazardous.

WarningsignsshallbeinEnglish,KannadaandHindiLanguages.

SiteWorking Hours

TheSiteworkinghoursaredetailedintheContractData.

TheContractorshallnotextendtheworkinghourswithoutthepriorapprovalofthe Engineer.

DeliverytoSite

TheContractorshallberesponsibleforthetransporting,handling,anddeliverytositeo fallthePlant and equipment. The proper storage and protection of all Plant and equipment at the Site shall be the Contractor's responsibility.

TheContractorshallcheckallitemsagainstpackinglistsimmediatelyondeliverytothe Siteandshall also inspect for damage and shortages. Damages and shortages shall be remedied with the minimumof delay.

The Contractor may, with the prior approval of the Engineer and at no extra cost to the Employer, makearrangementsforanyothercontractororagenttotakedeliveryof,unloadandstor ethePlanton the Site on behalf of the Contractor.

AlldeliveriesshalltakeplaceduringtheContractor'snormalworkinghours.

ProtectionfromWeatherand Storage

Anareaand/ orbuildingontheSiteforusebytheContractorforstorageofPlantpriortoerectionwill be subject to the approval of the Engineer.

TheContractorshallprovideallfacilitiesforthesafeandproperstorageofPlantande quipment,as recommended bythe manufacturers,with particularconsideration beinggiven to temperature, rain, sunlight, wind and ground conditions.

TheContractorshallremainresponsibletotheEmployerfor thecareandinsuranceofthePlantand the provisions of this Clause shall not relieve the Contractor of any of his liabilities under the Contract.

StoredPlantitemsshall belaidoutbytheContractortofacilitatetheirretrievalforuseintherequired order as recommended by the manufacturer.

StackedPlantitemsshallbeprotectedfromdamagebyspacersonloaddistributingsupportsandshall be safely arranged. No metalwork shall be stored directly on the ground.

SmallPlantitemsshallbeheldin suitablebins,boxesorracksandbeclearlylabelled.

ItemsofPlantshallbehandledandstoredsothattheyarenotsubjectedtoexcessivestressesandso that protective coatings are not damaged.

TheContractorshallcomplywiththemanufacturer'spackageandplantmarkingsconcerningtheuse and location of lifting slings, chains and hooks, and all other handling, storage, protection, and installation instructions.

ContractSignboards

TheContractorshallsupplyanderectsignboardsatlocationstobespecifiedbytheEngineer.The layout and dimensions of the signboards and their construction shall be to the approval of the Engineer and the lettering in Kannada, Hindi and English Languages shall be black on a white background.

Advertising

TheContractorshallnotuseanypartoftheSiteforanyformofadvertisingwiththepriorwritten approval of the Engineer.

EndofPart-2

PART3

GENERALREQUIREMENTS

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PART3

GENERALREQUIREMENTS

Introduction

ThisPartsetsoutthetechnicalrequirementsthataregeneraltothe Contract.

TechnicalStandardsand Regulations

Except where otherwise specified in the bid document plant, materials and workmanship shall comply with the requirements of the relevant Indian Standards (hereinafter referred to as IS) issued by the BureauofIndianStandards.OtherequivalentNationalorInternationalStandardSpecificationssuchas those issued by the International Organisation for Standardisation (ISO) or the International Electrotechnical Commission (IEC) may be substituted by the Contractor (so as long as they are more stringent than the equivalent IS) at the sole discretion of the Engineer or as may have been agreed in the Contract. All standards used shall be the current and latest version.

TheElectricalinstallationshallcomplywithallrelevantstatutoryregulationsandstandardscurrentat date of bids, unless otherwise indicated within the Employer's Requirements. Electrical installations shall, where relevant, be in accordance with the Indian Standards Code of Practice for Electrical Wiring Installations IS 732.

Allmaterials,plantandequipmentshallbenewandallmaterialsandworkmanshipnotfullyspecified herein or covered by an approved standard shall be of such kind as is used in first class work and suitable to the climate in the project area.

Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to `B.S.') issued by the British Standards Institution of 2, Park street, London W.I., or to an Indian Standard Specification (I.S.) issued by the Bureau of Indian Standards, (earlier known as Indian Standards Institution), Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002, or AmericanSocietyforTestingandMaterials(ASTM)issuedbyASTM1916RaceStreet,Philadelphia, P.A., 19103, U.S.A. or American National Standards Institute (ANSI)

issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A. or Japanese Industrial Standards (JIS) issued by Japanese

StandardsAssociation,4-1-24,Akasaka,Minato-Ku,Tokyo107,Japanortoanyotherequivalent Standard it shall be to the latest revision of that Standard at the Tender opening date.

The Contractor may propose, at no extra cost to the Employer, the use of any relevant authoritative internationallyrecognisedReferenceStandard,includingIndianStandard(IS)andJapaneseIndustrial Standards (JIS).

All details, materials and equipment supplied, and workmanship performed shall comply with these Standards.IftheBidderoffersequipmenttootherStandards,theequipment/materialshouldbeequal or superior to those specified and shall be subject to approval by the Engineer and full details of the difference shall be supplied by the Contractor.

In the event of conflict between this Specification and the Codes for equipment, the most stringent provision shall govern, except as otherwise approved by the Employer. Certain Specifications issued bynationalorotherwidelyrecognisedbodiesarereferredtointhis Specification.Such specifications shall be defined and referred to hereinafter as Standard Specifications. In referring to the Standard Specifications the following abbreviations are used:

IS :IndianStandard

ANSI :AmericanNationalStandards Institute

API : AmericanPetroleumInstitute

ASME : AmericanSocietyofMechanical Engineers

ASTM : AmericanSocietyofTestingandMaterials

AWS : American Welding Society

AWWA : AmericanWaterWorksAssociation

ISO : InternationalOrganizationforStandardization

JIS : Japanese Industrial Standard

DIN : DeutschesInstitutefurNormung

BS : British Standard

JWWA : JapaneseWaterWorksAssociation

IEC :

InternationalElectrotechnicalCommission IEE

: Institution of Electrical

Engineers

IEEE :

InstituteofElectricalandElectronicEngineers NEMA :

National ElectricalManufacturers

Association AGMA : American Gear

Manufacturer’s Association

PrecedenceofEmployer’sRequirements

TheRequirementsspecifiedintheParticularRequirementsparts,shallbeinadditionto thosespecified in the General Requirements parts. In case of conflict between the parts, the requirements of the Particular Requirements parts shall take precedence.

Units of Measurement

Alldesigns,drawings,specificationsandmanualsshalluseSIunitsandallmeasuremen ts,dimensions and performance data shall be quoted in those units.

Programme

InaccordancetoSubClause8.3oftheParticularConditionsofContract,theContract orshallsubmit
withininthestipulatedtimedetailedcontractprogrammeforapproval,whichshallin cludedetailsof all temporary and permanent works, construction procedures and methodologies.

Inadditiontotherequirementssetdownintheconditionsofcontracttheprogrammeshallinc ludethe following details:

(a) Contractor’s organisational familytree for the Contract includingdetails ofall site supervisors and their responsibilities.

(b) A statement giving the numbers and categories of supervisory and technical staff and skilled and unskilled labour to be employed on the Works.

(c) A list and type details of major constructional plant (including vehicles) which the Contractor proposes to employ on the Works, including programmed dates for order and delivery.

(d) DetailsoftheContractor'smethodsofworkingforalloperations.

(e) A statement giving the proposals for location or locations and sizes of offices, workshops and stores at the Site.

(f) A complete resource allocation showing the number of units and allotted times for each unit of constructional plant, materials and labour allocated to each part of the Works.

Theprogrammeshallbeco-ordinatedtotakeintoaccounttherequirementsofclimatic,groundwater and other conditions to provide for the completion of the Works in accordance with the Contract.

TheprogrammeshallbepreparedusingMSProjectsoftwareandshallbesubmittedonbothsoft copy(editable copy)and paper.

Contract Management

TheContractorshallberesponsibleforadministrationoftheContractfromawardofContractthrough design, manufacture, manufacturer's works testing, and delivery of Plant to Site, installation, testing and performance testing to final take over. For this purpose he shall nominate a Contractor’s Representative in accordance with Sub-clauses of the General Conditions of Contract who shall be fully responsible for and undertake this administration.

SpecificresponsibilitiesoftheContractor’sRepresentativeshallbe:

(a) The sole representation on behalf of the Contractor in all discussion, correspondence and matters relating to the Works.

(b) The co-ordination and monitoring of Contract progress, which shall include the preparation of the Contract programme, monitoring of progress and submission of monthly progress reports. At the discretion of the Engineer, regular meetings shall be called at which the Contractor’s

Representative shall give a full account of the Contract progress and programme.

(c) The co-ordination and checking of designs, drawings and submissions. The Contractor’s Representative shall be responsible for co-ordinating the design, technical information anddata between Sub-Contractors. All calculations, drawings and information submitted to the Engineer shall be checked by the Contractor’s Representative and certified as having been checked before submission.

(d) Contract communication between the Engineer and the Contractor. The Contractor’s Representative shall attend all meetings involving the Contractor and the Engineer.

(e) The Co-ordination and programming of manufacturer's works tests and the submission of test certificates.

(f) Theco-ordinationandprogrammingofPlantdelivery.

(g) The co-ordination and programming of the installation of Plant on the Site, site tests and take over trials. The Contractor’s Representative, although not necessarily based at the Site, shallbe responsible for the various sub-contractors. At the discretion of the Engineer regular site meetings will be held during which the Contractor’s Representative shall give full account of site progress and programme.

(h) The Contractor’s Representative shall also be responsible for producing in advance of thework being undertaken, detailed method statements of any work, which involves or affects the performance of existing equipment, processes, or disruption to existing water supplies.

(i) The co-ordination and preparation and submission of As-Built Drawings and Operation and Maintenance Manuals.

(j) Soft copies of all submissions should be in editable form by word, excel, pdf and AutoCAD 2020.

(k) ThepreparationandCo-ordinationoftrainingofEmployer’sPersonnel.

(l) Thesubmissionofapplicationsforpayment.

Meetings

FromtimetotimetheEngineerwill callmeetingsinhisofficeorattheContractor'soffice,orat the Site, as he deems necessary, to discuss progress and any technical points requiring settlement.

TheContractor'sRepresentativeorresponsiblerepresentativeshallattendsuchmeetings.

TheContractorshallprepareandsubmittotheEngineeradailyactivityreportsummarisingthemain activities undertaken each day. As well as problems in design and construction, safety management information, progress of construction by S-Curve Chart.

Site Photographs

In accordance with the requirements of the Conditions of Contract the Contractor shall supply soft copies of photographs and unmounted positive colour prints not less than 150mm x 100mm of such portions of the Works, in progress and completed, as may be directed by the Engineer and specified herein.Thesoftcopiesandprintsshallnotberetouched.Thesoftcopyofeachphotographshallbethe propertyofthe Employer and shallbe delivered to theEngineer withtheprints. No printsofthese soft copies shall be supplied to any other person without the written permission of the Engineer.

Thephotographsshallbeofthreecategories:

- Original/Beforeconstruction
- Progress Photographs
- RecordPhotographs

Theabovecategoriesofphotographsshallbeproperlyreferencedtotheapprovalofthe Engineer,and on thebackofeachprintshallbe recordedthedate andtime of the photograph, thedirectionin which the camera was facing, an identifying description of the subject and the reference.

Photographs taken for record purposes as ordered by the Engineer or as specified herein shall be suppliedwithsoftcopyandthreeprints,havingthereverseofonesuperscribedwiththe

signaturesof the Contractor and the Engineer (or their authorised representatives) for the purpose of attestation. If

required,theContractormayathisownexpensehaveanadditionalprintsimilarlyattested forhis retention.

The Contractor shall supply one soft copy and three prints dated with description of each progress photograph ordered by the Engineer. The Contractor shall supply two additional prints dated with description of progress photographs selected by the Engineer for incorporation in albums. The Contractorshall supplytwosetsofalbums, mount theprints,andtitletheprintsandalbumsalltothe approval of the Engineer.

ThetakingofphotographsoftheWorksbytheContractorforanyotherpurposewhether forusein India or in any other country shall not be carried out without written approval from the Engineer.

A)Setting Out of the Works

Thecontractorshallreceiveengineer’sinstructionsforreferencepointsandelevation pointsas benchmark.

The Contractor shall set out the Works and carry out the Contractor’s quality control procedures verifyingthe accuracyand precision of the settingout for eachitemof the works. The Contractor shall notifytheEngineersufficientlyinadvanceofthesettingouttoenabletheEmployersRepresentativeto observetheaccuracyandprecisionofthelayingout.TheobservationsoftheEngineersh all not relieve theContractoroftheresponsibilityundertheContractfortheaccuracyandprecisionofthesettingout.

The Engineer shall approve dimensioned drawings, levels and other information necessary to enable the Contractor to set out the Works, at his own cost.The contractor shall provide all instruments such as theodolite, total station, leveling instruments in good working condition. The contractor shall also provide pegs, ranging rods, long measuring rods, marked meters and decimeters and each meter and decimeter numbered, posts and sight-rails, boning rods, moulds, template etc., together with any reasonable number of laborer that may be required and set out the Works and be responsible for the accuracy of the same. The Contractor shall amend at his own cost and to the satisfaction of the Engineeranyerrorfoundatanystagewhichmayarisethroughinaccuratesettingoutunlesssucherror is based on incorrect data furnished in writing by the Engineer. The Contractor shall protect and preserve all control points and benchmarks used in setting out the Works till the end of the Defects Liability Period unless the Engineer directs its early removal. The Contractor should also keep the

theodolite and leveling instruments in good working condition throughout the period of construction work on site.

Thecheckingofanysettingout orofanylineorlevelbytheEngineershallnotinanywayrelievethe Contractor of his responsibility for the correctness thereof.

Noseparatepaymentwillbemadefor settingouttheWorksasrequired.Unitratesquotedbythe Contractor for all items will be deemed to have covered the expenses for such setting out.

B)DetailsandDatamadeavailableby Employer

TheEmployerhasthefollowingdataavailableandusedtheseinformulationofthebidelements.They arelistedbelowandshallbeusedonlyasguideline.TheEmployerdoesnot,however,guaranteeeither the sufficiency or accuracy of the data provided. Contractor shall carry out fresh survey, investigation and particular testing/and all other details necessary for proper planning, detailed design andexecution. The Contractor will be required to provide full details of the investigations and analysis for approval of the Engineer.

- KeyPlanofSTP&ISPSAccessRoad
- Boundary

Engineer’sRequirements

The Contractor shall provide the following for use by Engineer at the each proposed STP plant & ISPS sitescoveredunderthecontract.Theseitemsaretobemaintainedbythe Contractorinproper,safe,and clean working condition throughout the construction period.

(a) Engineer'sStaffSiteOffice

(b) FirstAid

(c) UPS

(d) Domesticwater

Engineer'sStaffSiteOffice

A separate office (PORTACABIN), with toilet facilities for the sole use of the Engineer, his staff and Consultant shall be provided by the Contractor at STP and ISPS site. The Contractor shall provide, erect,furnish,clean,maintainandsubsequentlytransfertheassociatedfurniture/

itemstotheEmployer after the completion of works.

ThelocationoftheofficeshallbeasdirectedbytheEngineer.

The Engineer’s staff office shall be ready in all respects within 60 days after Contractor takes possession of the site.The Office shall be maintained throughout the construction period with office help staff, power, water, sewerage, and housekeeping. These amenities shall be arranged by the Contractoreitherwiththeavailableresourcesorfromindependentsources(e.g.diesel generatorsets, borewells, etc.) at his own cost.

Theequipment,furniture,andfurnishingsshallinclude:at STPs

(a) 4Nos.of4’x2½’tablewithdrawersonbothsides(3oneachside)
(b) 2Nos.of3’x2’tablewithsinglesidethreedrawers
(c) 10NosChairs(approvedmake)
(d) Conferencetableof12 sitters.
(e) LAPTOP(withhighendspecificationasmentionedbelow)withbasicinstalled software like MS Office, Autocad & Stadd pro, Antivirus & Malware software.

Make	HP/Dell / Lenovo
Quantity	1 No.
CPU	IntelCoreI7,4GHzorLatestavailableat the time of supply.
DDR RAM	8GBDDR4RAM(slotfor1No.additional RAM slot should be provided)
Harddisk	1 TB
Storagemedium	DVDR/Wdrive
VDU	17”FHDScreenwithwideangleviewing with better resolution.
Integrated	10/100/1000 Mbps Ethernet LAN interface cardIEEE802.11Bconnectivityport(Itshall be possible to connect the laptop to the Ethernet switch provided in the respective location. Necessary port shall be provided in the Ethernet switch)
Communicationports	Oneserial,oneparallel,min.fourUSBports, blue tooth & WIFI enabled, minimum one Ethernet port, internal modem required.
Mouse	Opticalmouse&Touchpad
Powersupply	UniversalACadapter:100to240VAC(50

	Hz)input;Batteryrequiredwithmini mum8

	hrsbatterybackup.
Speakers	Required.TheLaptopshallbeprovided with necessarysoundcards& drivers.
Anyother features	Allstandardfeaturesavailableona laptop.
Cables&accessoriesrequiredfor connecting to Ethernet Switch	Required.
Softwaretobe loaded	Windows-10 or latest Operating System Software, MS office 2010, Latest version of Adobe Acrobat read/write software. Latest versionofanti-viruskitshallbeprovidedwith licensefor3yearupgradation. (ReferNote-9)
Recovery/BackupCD/DVDs/othersuitablenon-volatilestoragemedium	
Requiredforallthespecifiedsoftware&driversforservers,Workstations, engineering station, Laptop	

- HPColourLaserJetPrinter(suitableforA4/A3sizepaper)orequivalent
- Allthenecessaryconsumablesincludingpaper,CDs,printercartridges etc.

(f) FireExtinguisher –CO_2type(3Kg)–4sets (min).

(g) CellphonewithSIMforcontractperiod-1noandHighSpeedBroadbandwith running costs tobe borne by contractor throughout the contract period.

(h) First Aid

(i) Domesticwater

(j) Toilet

Noseparatepaymentshallbemadefortheitemscoveredhere

Vehicles

The Contractor shall purchase and maintain one new INNOVA top/highend/Equivalent vehicle for the contract to be kept available at all times for the sole use of the Engineer and his staff at contractor's cost. The Contractor shall be solely responsible for the upkeep of the vehicle including taxes, insurance, licenses, fuel, oils, lubricants, repairs, and maintenance and shall also provide a competent driver along with the vehicle and driver shall be familiar with Kannada and Hindi Languages. At the end of contract (after successful completion of O&M period) the Contractor shall transfer the vehicles in good condition to Employer.

No extra payment shall be made on this account.

Assistancetothe Engineer

TheContractorshallprovideallnecessaryassistancetotheEngineerandhisstaffincarryingouttheir duties of checking, inspecting, and measuring the Works. The Contractor shall provide, at no additional cost, chainmen, staff men, office attendants, and labourers as may be needed from time to time by the Engineer.

TheContractorshallprovidefortheEngineerandhisstaff,consultantsandtheirstaffandvisitorssuch protective clothing, safety helmets and rubber boots of suitable sizes, hand lamps and the like as may be reasonably required by them. These articles shall remain the property of the Contractor. No extra payment shall be made on this account.

Erectionof Plant

ErectionofPlant shall bephasedinsuchamannerasnot toobstructtheworkbeingdonebyother contractors.

Before commencing any erection work, the Contractor shall check the dimensions of structures where thevariousitemsof Plant aretobeinstalledandshallbringanydeviationsfromtherequiredpositions, lines or dimensions to the notice of the Engineer.

Plant shallbeerectedinaneatandworkmanlikemanneronthefoundationsandatthelocations shown on the Approved Drawings. Unless otherwise directed by the Engineer, the Contractor shall adhere strictly to the aforesaid drawings.

TheContractorshallberesponsibleforsettingupanderectingthePlant tothelineandlevelrequired and shall ensure that all Plant is securely held and remains in correct alignment before, during and after grouting-in. This responsibility shall not be passed to any other contractor.

Any damage caused by the Contractor during the course of erection to new or existing plant or buildingoranypartthereto,theContractorshallathisowncost,make good,repairorreplacethe damage,promptlyandeffectivelyasapprovedbytheEngineerandtotheEngineer's satisfaction.

SiteLabourand Supervision

TheContractorshallprovidealltheskilledandunskilledlabourrequired,andallnecessaryto olsand equipment, to erect, test and commission the Works within the period agreed in the programme.

TheContractorshallnotremoveanysupervisorystafforskilledlabourfromtheSitewith outthe Engineer's prior approval.

Sub-letting

The Contractor shall not sub-let the whole of the Works. Where any design or manufacture is sub-let, the Contractor shall not be relieved of his obligation under the Contract.The Contractor shall be responsiblefortheacts,defaultsandneglectactsinmanufactureordesignofanySub-Contractor,asif they were his own.

Where the Engineer has consented to supply of Plant equipment or execution of work by manufacturersorsub-contractorsproposedbytheContractor,suchmanufacturersorsub-contractors shall not be changed without the prior approval in writing of the Engineer.

Acopyofeverysub-ordershall besent totheEngineeratthetimetheorderisplacedeachclearly marked with the title of the Contract and the Contract number.

TemporaryWorks

Notlessthan14daysbeforecommencinganyportionoftheWorks,theContractor shallsubmittothe Engineer for his approval comprehensive drawings and calculations for all Temporary Works which the Contractor proposes for the construction of that part of the Works.

NotwithstandingapprovalbytheEngineerofanydesignfortheTemporaryWorks,t heContractor shall be entirely responsible for their safety, efficiency, security, and maintenance and for all obligations and risks in regard to such Temporary Works specified or implied in the Contract.

Languages

Alldrawings,instructions,signs,notices,name-plates,etc.foruseinthedesign,construction, operation and maintenance of the Works shall be in English.

AllsitesignboardsandwarningsignsshallbeinKannadaandEnglish Languages.

DrawingsandInformationtobeProvided

General

The drawings that will be prepared and issued for this Contract shall be classified as follows and whererelevantshallbetoascalewhichissuitablefortherepresentationofthosedetails illustrated.

ThetermDrawingshall bedeemed to include alldrawings, schedules,lists, software documentation, descriptivetextandcalculationsnecessaryforthedesign,construction,operationandmaintenanceof the Works and referred to in this clause.

Drawings and all other submittals required during bidding stage and after award of Contract shall be submitted in editable electronic softcopy format on CD(s) or DVD(s) as well as in hardcopy paper format. The Contractor shall submit plan and levels of the, incoming sewers/Rising mains, STPs and ISPSsinsoftcopiesandsixhardcopiestotheclientforapproval.Theapprovedsoftcopyofthesewer network drawings shall be provided to the contractor for correction and submission of required numbers of hard copies of the drawings.

Thesoftcopyformatforvariousitemsshallbeas follows:

- Drawings:AutoCADversion2020
- TextDocuments:MicrosoftWordversion2019andaboveincludingMicrosoft Project
- Spreadsheets,Hydraulicdesign/capacity/ powercalculations,tables,technicalschedules,prices schedules, and other numerical data: Microsoft Excel version 2019 and above
- All other required information not included in the above: Adobe Portable Document Format(PDF) version 7.x

Thehardcopyformat/sizesforvariousitemsshallbeas follows:

- Drawings: Standard A1 size paper. The scale for each drawing shall be selected such that the information is presented without any clutter or ambiguity and is clearly and easily legible without the use of magnifying aids other than a reader's normal eye-glasses.
- All other information: Standard A4 or A3 paper size, except for any pre-printed standard information such as brochures or catalogue information, which may be submitted in the original size and format.

DrawingFormatandNumbering

All drawings shall be prepared using an identical title block format. This shall be approved by the Engineerandshallidentifytheproject,drawingtitle,theEmployer,theContractor,Sub-contractor,if applicable, and the Engineer.

A formalised drawing numbering system shall be adopted with digits of each number, referencing location,revision,drawingtypeandsize.Thenumberingformatandallocationofdrawingnumber blocks shall be approved by the Engineer.

TheContractorshallprovideasequentialnumberingsystemforallConstructionDocuments.The drawing number shall not be repeated or duplicated.

Alldrawingsshallbesubmittedtoaformalisedcheckingprocedurepriortosubmission. Drawingsnot so checked will not be approved.

Pre-contractDrawings

The Pre-contract Drawings are those issued to Bidders either with the Bidding Documents for the purposeofillustratingandclarifyingtheWorksdescribedintheEmployer'sRequirementsorlater during the bidding period as part of an Addendum to the Contract Documents.

Suchdrawingsshallbedeemedtohavebeenissuedfortheguidanceof Biddersandshall, forthe purpose of executing the Works, be superseded by the Construction Documents.

BidDrawingsand Details

TheBidDrawingsarethosefurnishedbyaBidderwithhisBidforthepurposeofillustratingand clarifying his proposals.

Thefollowingdrawings,detailsandspecificinformationpertainingtotheentirese wagetreatment process/plant/ISPSs/SewernetworkshallbefurnishedbytheBidderforeachSTP/ ISPSinthe technical envelope in addition to other information mentioned elsewhere in the tender.

Thelistsprovidedbelowshallnotbeconsideredcomprehensive.Thebiddershallbere sponsiblefor all drawings and information for any and all works that may be necessary for full and complete definition or clarification of the design, regardless of whether or not such drawings, information, or works are explicitly included in the lists below or elsewhere in these bid documents.

Thebiddrawingsandothertechnical documentsshallbesubmittedinsoftcopyformatonCD(s)or DVD(s) as well as in hardcopy paper format.

(a) GeneralandProcess

(i) NarrativeDescriptionoftheWorks.
(ii) PlantOperationandControlPhilosophy.
(iii) Sizing and Design Calculations covering all Major Unit Processes and components of the Works.
(iv) Listof allstructures (basins,tanks,channels,buildings,etc.) includingdimensionsand freeboards.
(v) CompleteEquipmentList.
(vi) Plant Layout.
(vii) HydraulicProfile.
(viii) ProcessFlowDiagram.
(ix) ProcessandInstrumentationDiagrams(P&IDs)
(x) ElectricalLoadList&PowerConsumptionChart.
(xi) ListofChemicalConsumptiononDaily/MonthlyBasis.

(b) Mechanical

(i) To-scaledimensionallayoutand/ orinstallationdrawingsforthefollowingEquipment, at a minimum:
- RawSewagePumpsets
- DewateringPumps,Screens,Gates,Valvesetc.

(ii) Graphs for all major pumps (including but not limited to Raw Sewage Pumps Performance Curves: Q vs H, speed, P, Efficiency, and NPSH).

(c) Efficiencycurvesofthepumpmodelproposed

(i) ElectricalSingleLineDiagram.
(ii) SizingCalculationsforTransformersandDG Set.

(iii) SpecificEnergyConsumption.

(iv) TechnicalSchedulesforElectricalWorksdulyfilledin.

(v) InstrumentationSCADA.

(vi) Constructionschedule.

DetailsofDrawingsandCalculationstobesubmittedbytheContractorforApproval

Drawings/ Calculationsforapprovalshallbesubmittedbytheselected Contractorafterawardofthe contract in two Stages.

Thefirstphaseshallbe thePreliminaryDrawings/Designs.Drawings/ Designssubmittedduringthis phase shall be of sufficient detail for the Employer and Engineer to understand in outline the Contractor's proposals for the design and construction of the Works.

ThePreliminaryDrawings/ DesignsforeachSTPandeachISPSwithassociatedpumpingmainshall inter alia comprise:

- DetailedDescriptionoftheproposedSewageTreatmentPlantandTreatmentProcessoffered (including Raw and Treated Sewage Quality).
- DetailedPlantOperationandControl Philosophy.
- DetailedProcessDesignCalculations/MassBalanceCalculationscoveringallUnits/ Equipment.
- DetailedListofUnitsincludingUnitDimensions/FreeBoards.
- DetailedEquipmentList.

- MajorEquipment/InstrumentSpecifications(withsupportingBrochures).

- MajorPiping Scheduleto include size,material,coating,lining,gauges/thickness,andpressure rating.
- Major Valve Schedule to include size, type, material, pressure rating, operator/actuator type, and whether Open/Close or Modulating.
- Gate Schedule to include size, type, differential head, seating or unseating, operator/actuator type, and whether Open/Close or Modulating.
- Detailed Plant Layout (including Pipe Sizes/ Pipe Routing/ Channel Size/ Channel Routing/ SiteRoads/ Site Drainage/each processing facilities).
- DetailedHydraulicProfileincludingHydraulicCalculations.
- DetailedProcessFlowDiagram(inclusiveofMassBalance).
- ProcessandInstrumentationDiagram(P&ID)andSCADA.
- DetailedChemicalConsumptionCalculations(Daily/MonthlyBasis).
- TransformersizingcalculationforSTPbasedonapprovedElectricalloadlist.
- D.GsizingcalculationforSTPbasedonapprovedElectricalloadlist.
- FullHazardousAreaClassificationAnalysisandReportperIS5572forSTPinthecontract.
- HazardousAreaClassificationDrawingsperIS5572forSTPinthecontract.
- DesignConceptReportforElectricalEquipmentincludestotalpowerconsumption.

Thesecond stage shall bethe Detailed EngineeringDesign phase and shall comprise the submission of the Detailed Mechanical/ Electrical/ Instrumentation/ SCADA/ Structural/ Civil ConstructionDrawings and Calculations. These shall be submitted after the approval of the Preliminary Drawings. The lists provided below shall not be considered comprehensive. The bidder shall be responsible for including any and all drawings and information for any and all works that may be necessary for full and complete definition or clarification of the design, regardless of whether or not such drawings, information, or works are explicitly included in the lists below or elsewhere in these bid documents.

TheConstructionDocumentsshallbeusedfortheconstructionoftheWorksandshallinteralia comprise:

(a) Civil

SitelayoutsforeachSTPsandeachISPSsprovidinginformationonlevelsanddetailing thelocation of:

- Generalarrangementsandmainsectionsofallplantareas.
- Plans,elevationsandmainsectionsofallstructuresandbuildings.
- Buildings.
- Storagetanks.
- Processplants.
- Transformerenclosures.
- Roadways.
- Drainage(plantdrainage,sanitationandstormwaterdrainage).
- Buriedpipelines.
- Cableroutesfordirect ingroundandductedsystems.

DetaileddrawingsforRisingmainbasedonsoftcopiesprovided

- Plans,L-SectionsofRisingMain

Detaildrawings of:

- Cableandpipeworkchambers.
- Buriedpipework.
- Pipeworkconnections.
- Contractinterface.
- Reinforcementdrawings.
- Barbendingschedules.

Calculationsfor:

- DetailedStructuralDesigncalculationofalltheunits/Structures.
- DetaileddesignofRisingmainincludingthecalculationof diameters.

(b) Hydraulic

- Detailedhydraulicprofile(STP,sewernetwork,ISPS&dischargepipe).
- Detailedhydrauliccalculations(STP,sewernetwork,ISPS&dischargepipe).
- PlanandL-SectionprofileofPumpingMain.

(c) Process

Drawings:

- Processflow diagram.
- ComprehensiveP&IDsincludingdetailsof.
- Pipelinesizesand materials.
- Valvesizeand type.
- Equipmentdetail.
- Instrumentation.
- IdentificationofcontrollingPLC.

Calculationsfor:

- DetailedProcessDesignCalculations/MassBalanceCalculationscoveringallUnits/ Equipment.
- DetailedListofUnitsincludingUnitDimensions/FreeBoards.
- DetailedEquipmentList.
- MajorEquipment/InstrumentSpecifications(withsupportingBrochures).
- MajorPipingScheduletoincludesize,material,coating,lining,gauges/thickness,and pressure rating.
- Major Valve Schedule to include size, type, material, pressure rating, operator/actuator type, and whether Open/Close or Modulating.
- Gate Schedule to include size, type, differential head, seating or unseating, operator/actuator type, and whether Open/Close or Modulating.
- DetailedProcessFlowDiagram(inclusiveofMassBalance).
- DetailedElectricalPowerConsumptionCalculations.
- DetailedChemicalConsumptionCalculations(Daily/MonthlyBasis).

(d) Mechanical

Drawings:

Outlinedimensionaldrawing&CrosssectionDrawing(withBillofQuantityandMaterialof construction) for the following items for each STPs and each ISPSs, but not limited to:

1.	RawSewagePumpset
2.	ISPSCoarse screens
3.	J-typeScreens
4.	BeltConveyorfor screenings
5.	Non-Returnvalves
6.	KnifeGateValves
7.	Dismantlingjoints
8.	ElectricHoist
9.	SluiceGates&WeirGates– Motorised
10.	DewateringPump sets
11.	AirValves
12.	SluiceValves

13.	DomesticPumpset
GraphsforallPumps(includingbutnotlimitedtoRawSewagePumps,Dewatering Pumps): Pump Performance Curves: Q vs H, speed, P, Efficiency, and NPSH Efficiencycurvesofthepumpmodel proposed	

(e) Electrical

Drawings:

(1) Detailed Electrical Load List for all STP/TSPS& ISPS prepared based on approvedEquipment list from process and Mechanical.
(2) Transformer sizing calculation for all STP/TSPS& ISPS based on approved Electrical load list.
(3) D.GsizingcalculationforallSTP/ TSPS&ISPSbasedonapprovedElectricalloadlist.
(4) Single Line Diagram of Complete Electrical System for STP/TSPS & ISPS based on the equipment finalized by Mechanical and Process.
(5) ElectricalSubstationLayoutofSTP/ TSPS&ISPSshowingPanellocations, Transformer locations and Trench Layout.
(6) 11kV Switchgears:
    (a) GuaranteedTechnicalParticulars.
    (b) DimensionalDrawingshowingoveralldimensions,plan,elevation andcable entry details.
    (c) Complete assembly` drawings of the Switchgear showing plan, elevation and typical sectional views, details of busbars and locationof cable end boxes and control cable terminal blocks for external wiring connections, etc.
    (d) Foundation plan showing the location of channel sills, anchor bolts and anchors, floor plans and openings.
    (e) Single Line Diagram, Schematic power and control wiring diagrams along with control& interlock details, complete bill of materials indicating make, type, rating, setting etc of Circuit breakers, relays, contactors, current transformers, potential transformers, instruments, meters, annunciations etc.

(7) DieselGeneratorSet
    (a) GuaranteedTechnicalParticulars.
    (b) GA Drawing showing overall dimensions, plan, elevation, sectional views, mounting arrangement, layout, make, type, rating etc of diesel engine, Alternator, Control panel, battery, battery charger etc.

(c) SingleLine&SchematicdiagramsshowingdetailsofPower &Control,AMF details, interlocks, protections, annunciations, battery, batterycharger etc with make, type, rating, setting etc of various equipment, components etc.

(d) Foundation plan showing the location of channel sills, foundation, anchorbolts and anchors, floor plans and openings.

(e) Exhaustsystemwithpipinglayout.

(f) Dayoiltanksizingwithmountingarrangement details.

(8) 11kV/433kVTransformers

(a) GuaranteedTechnicalParticulars.

(b) General arrangement drawing of the transformer, showing plan, frontelevation and side elevation complete with all accessories and fittings,detailed dimensions, net weights, quantity of oil, clearances between HV terminals,betweenLVterminals,betweenHVandLVterminals,betweenHV & LV terminals and ground etc.

(c) Rating, diagram and terminal marking, complete with polarity and vector group.

(d) Controlwiringdiagramformarshallingbox.

(e) Foundationdrawingwithpositionoffoundationboltsand depth.

(9) L.T Panels, Distribution Boards, Power Control Centres, Power Motor Control Centres, Motor Control Centres etc.

(a) GuaranteedTechnicalParticulars.

(b) DimensionalDrawingshowingoveralldimensions,plan,elevation andcable entry details.

(c) Complete assembly drawings of the switchboard/distribution board / MCC showing plan, elevation and typical sectional, views, details of busbars and location of power &control cable terminal blocks for external wiring connections, etc.

(d) Foundation plan showing the location of channel sills, anchor bolts and anchors, floor plans and openings.

(e) Single Line Diagram &Schematic power and control wiring diagrams along details, complete bill of materials indicating make, type, rating, setting etc of Circuit breakers, relays, contactors, current transformers, potential transformers, instruments, meters, annunciations etc.

(f) FeederOperationandInterlocklogic.

(10) L.TCapacitorbankwithAutomaticPowerFactorCorrectionRelay

(a) GuaranteedTechnicalParticulars.

(b) Fully dimensioned general arrangement drawings of capacitor and capacitor control panel with elevation, side view, sectional view and foundation details.

(c) Justificationfornumberofstepsforswitching.

(d) Single Line Diagram, Schematic and wiring diagrams for capacitor control panel complete with bill of materials.

(11) VariableFrequencyDrives

(a) GuaranteedTechnicalParticulars.

(b) Dimensionaldetailswithmountingarrangement.

(c) Single Line Diagram & Schematic power and control wiring diagrams along details, complete bill of materials indicating make, type, rating, setting etc of variousequipment/components/items,various

equipment /components/items.

(d) Specificdetailsofconverter,inverterandharmoniccontrol units.

(12) BatteryandBatteryChargerwithD.C.Distributionboard

(a) GuaranteedTechnicalParticulars.

(b) Dimensionedgeneralarrangementdrawings.

(c) Fullydimensionedgeneralarrangementdrawingsofbatteryandbatterycharger with elevation, side view, sectional view and foundation details.

(d) Completeschematicandwiringdiagramswithbillofmaterials.

(13) NonSegregatedLTBus duct

(a) GuaranteedTechnicalParticulars.

(b) Dimensionedgeneralarrangementdrawings.

(c) Layoutdrawingswithbillof materials.

(14) CablingSystem

(a) GuaranteedTechnicalParticularsofHT&LTPowerandControl Cables.

(b) Details of Installation of Cables in Trenches, on cable trays, directly buriedEtc at all locations inside the plant.

(c) Cableroutingplanandsectioninsidetheplant.

(d) 11kVCableterminationandmountingKitLayout drawing.

(e) Datasheetsforvariouscables.

(15) Lightingsystem

(a) Make, type, rating etc of various fixtures, receptacles, switches etc in various premises.

(b) Make, type, rating etc of various fixtures, lighting poles etc for street lighting and flood lighting.

(c) Detailed Room wise Lighting Layout with Type of fixture details and Circuit diagram showing phase wise load

distribution and interconnection between switches, fixtures, Lighting panel, receptacles etc.

(d) Internal road Lighting and Area lighting layout with location of poles, details of fixtures and mounting.
(e) StreetLightpoledetailswithFoundationdetails.

(16) EarthingSystemandlightningProtection

(a) Detailssuchasmaterial,sizes,etc.oftheearthconductorandelectrode pits.
(b) Earthing layout drawing showing routing of main grid inside the plant withdetails of interconnection of equipment earthing to the grid and earth pits.
(c) LightningProtectionLayout.

(17) ElectricalEquipmentandPanel Layout.
(18) Indoor&OutdoorLightingLayout.
(19) Indoor&OutdoorCabletrench,Cabletray&Cable Layout.

Schedules

(1) Cableschedules&billofquantities.
(2) ElectricalLoadandPowerconsumptionschedule.
(3) Protectionrelaysettingschedule.

Calculations

(1) SpecificEnergyConsumptionCalculations.

(2) Busbarsizingcalculationfor11KVSwitchgears,415VSwitchgearsetc.

(3) Co-ordinatedprotectionstudyasper IS13234.

(4) FaultlevelandVoltageDipCalculationsasperIS13234.

(5) HormonicAnalysisstudyfor VFDs.

(6) ArcFlashStudyasperIEEE 1584.

(7) SizingofCapacitorbanks.

(8) SizingCalculationforBatteryandBatteryCharger.

(9) NonSegregatedBusDuct.

(a) Sizingofthebusbarsvis-à-visthermalcapabilitytowithstandrated Continuous current and one second short time current.

(b) Spacingoftheinsulatorsvis-à-vismechanicalstrengthtowithstandforcesdue to momentary short circuit current.

(c) Heat loss and temperature rise calculations for conductor and enclosure. All formulae and other information from which the heat losses have been derived shall be enlisted.

(10) HTandLTCablesizing.

(11) Earthingsizingcalculation.

(12) RoomwiseLightingCalculationasperLuxlevelgiveninthespecification.

(13) OutdoorLightingCalculation.

(14) BuildingLightningProtectionandEarthingSizingCalculation.

(f) InstrumentationandControl

Drawings:

- Powersupplydistributionsinglelineandschematicsdiagrams(seenote1)foreachcontrol panel.
- Internalandexternal(seenote2)generalarrangementforeachcontrolpanel(dimensional).
- Controlpanelwiringdiagram,relaylogicdiagramalongwithterminalblockdetails.
- SystemconfigurationincludingcommunicationwithISPS,remotemonitoringfrom central SCADA stations.
- And layout diagram along with bill of material, program listings, block logic diagram and control logic write up for PLC.
- UPSandbatterysizingcalculations.
- Controlandinstrumentationloopdrawings(seenote3).
- Instrumentinstallationdetaildrawing(hookup,seenote4).
- Cableblock diagrams.
- Cablerouting/installationdrawings.
- Foundationandfixingdetailsandtrenches drawings.
- Mimicgeneralarrangement(fullcolourcopiesshallbeprovided).

Schedules:

- Cable schedule.
- Cableinterconnectionschedule.
- Controlandinstrumentationloadscheduleforeachcontrolpanel.
- I/Oschedule.
- Junctionboxschedule.
- Instrumentschedulewithmake,model&tagnos.
- Instrumentation,processcontrolsetpointschedule.

- Instrumentdatasheets.
- Spares Summary.

Documentation:

- DocumentControlIndex.
- Functionaldesignspecification(FDS).
- BillofMaterials Database.
- Factoryacceptancetestdocument(FAT).
- Siteacceptancetestdocument(SAT).
- As-
builtdocumentation.

Notes:

1. Schematic drawings shall include a comprehensive schedule of the components used in each switchboard, MCCand control panelincludingdetailsof the type, manufacturerand ratingof each component.
2. The external arrangement of each switchboard, MCC and control panel shall show thearrangement of all components including details of panel section, switch and instrument labels.
3. Control and instrumentation loop drawings shall show on a single drawing the complete circuit associated with an instrument or device including details and location of power supplies, cabling and terminations.
4. Hookupdrawingsshalldetailhowaninstrumentordeviceisinstalled.

Instrumentation,Electricalcontrolschematics,loopdiagramsandschedulesshallwherepracticalbe A3 size drawings; all other drawings shall be A1 size.

(g) MechanicalBuildingServices

Drawings:

- Singlelineschematicsforwastewatersystemanddrainagesystems;
- Generalarrangementdrawingsshowingthelocationofeachmechanicalbuildingserviceplant item;
- Generalarrangementofventilationsystems;
- Fixing details.

Schedule:

- PlantdatasheetswithEquipmentGAdimensionaldrawing,Foundationdetail,Calculationand Manufacturer’s Quality Assurance Plan.
- Pipelineschedules.
- Valveschedules.

Calculationsfor:

- System&Equipmentsizing.

TheEngineerreservesthe righttoaskforadditionalEquipment/systeminformationapartfromthe above to ascertain good system design and proper selection of Equipment.

As-BuiltDrawings

These drawings shall be compiled by the Contractor and shall constitute a permanent record of the Worksasexecuted.Theseshallincludeallsuchdrawings,schedules,documentationa ndcalculations as necessary for a complete understanding of the Works design, operation and maintenance.

The As-Built Drawings shall consist of the fully up-dated versions of the approved Construction Documents incorporating any additional information which will assist the Employer in operating, maintainingandifnecessarymodifyingorextendingtheWorksatalaterdate.Thesedra wingsshould extend and supplement the information given in the Operating and Maintenance Manuals.

A3 and smaller sized As-Built Drawings shall be provided on durable paper for reproduction by photocopier. As-Built Drawings larger than A3 sized shall be provided as a paper copy and also produced in the form of black lines on a durable translucent film from which further paper prints can betakenbyothersasrequired.Inaddition,drawingsshallbeprovidedasanAutoCAD(la testrevision) software copy in editable form in Compact Disc (CD) in two sets.

Textshallbeprovidedinanindustrystandardwordprocessing,spreadsheetordatabasefor matas appropriate (Editable copy).

OperatingandMaintenance Manuals

General

TheContractorshallcompileoperating,maintenanceandoverhaulinginstructionsfor thewholeofthe Plant.

Theinstructionsshallconsistofonevolumeof:

(a) General descriptive text (including drawings for illustration) of the Works described sectionby section.

(b) Complete operational instructions for the sewage treatment plant. This shall be termed the Operators Manual. It shall be aimed at the operational staff and shall be written in clear unambiguous text complete with drawings which necessary for clarification of any issues. The manual shall comprehensively detail what to do on a day-to-day basis and also what to do in the event of faults develop. It shall in addition provide a complete list of the process maintenance tasks the operator should carry out including the intervals between these tasks.

(c) Essential instructions for mechanical and electrical maintenance of the Plant. These instructions shall be short and concise and set out in a consolidated schedule the inspection, lubrication, cleaning and any other type of servicing operations required. The Contractor shall prepare typical maintenance log sheets that the Employer can subsequently use for daily, weekly, monthly or other periodic maintenance and shall form record sheets of plant maintenance operations.

(d) Instructions for use of skilled maintenance personnel in fault location, carrying out routine replacements, withdrawing, dismantling, overhauling, re-assembling and testing the various items of Plant.

(e) Manufacturer'sTechnicalDocumentationsubdividedintocategoriesfor:
- Civil.
- Process.
- MeasurementagainstInflowloadfluctuations.
- Deteriorationoftreatedwaterduetobulking.
- Othertroubleshooting.
- ManagingIndexforprocessoperations.
- Electrical.
- Electricalbuildingservices.
- Mechanicalbuildingservices.
- Instrumentationandcontrol.

(f) CivilAs-BuiltDrawings.

(g) ComprisingtheFDSandPLCcode.

(h) ElectricalAs-BuiltDrawings:Theelectricaldrawingsshallbecompletesetsincludingall information necessary for maintenance and spares replacement.

(i) ControlandinstrumentationAs-BuiltDrawings:Thedrawingsshallbecompletesets including all information necessary for maintenance and spares replacement.

(j) Mechanical As-Built Drawings:The mechanical drawings shall be complete sets includingall information necessary for maintenance and spares replacement.

(k) ElectricalandmechanicalbuildingservicesAs-BuiltDrawings:Thedrawingsshallbe complete sets including all information necessary for maintenance and spares replacement.

(l) FATrecordsforthePlantsand Works.
(m) SATrecordsforthePlantsand Works.

Eachvolumeshall besubdivided(relatingtoareasofplant)intosubsectionsorsub-volumesinorder to ease the location of plant details. Each volume or sub volume shall be provided with a comprehensive index for the volume or sub-volume concerned and the O & M manual as a whole.

Each volume shall be enclosed within A4 and A3 ring binders having tough grease resistant covers suitableforuseonsiteanddesignedtopermittheeasyremovalandinsertionoftheconte nts.Thefront cover and spine of each volume shall show details of the project, Employer, Engineer and a volume title.

Text shall generally be enclosed in A4 ring binders, A3 drawings shall be enclosed within A3 ring bindersexcept wheretheyaccompanyA4textinwhichcasetheyshall befolded.A1drawingsshall generally be folded and enclose in A4 box files. Where A1 drawings accompany text they shall be folded and enclosed in an A4 plastic wallet, one wallet per drawing.

SubmissionofDocumentsandDrawings

The Contractor shall supply to the Engineer 7 (seven) copies each (Hard copy & Soft copy) of the drawingsanddesigncalculationsfortheprocessandsizingofallcomponentsoftheSyst emincluding architectural, structural, mechanical, electrical and instrumentation equipment, supported by flow diagrams and general arrangement drawings for approval. It may be noted that soft copies of the AutoCAD sewer network drawings will be provided and contractor shall supply drawings as detailed above.

The Engineer may require the Contractor to submit for approval additional drawings if they are necessary to enable him to satisfy himself that the items are well designed, that they comply with the Employer’s Requirements and that they are suitable for their intended purpose. These drawings shall formtheagreedbasisfortheexecutionoftheWorks.Ifanapproveddrawingisrevised,re visedcopies shall besubmitted for approval as above and nosuchrevised drawingshallbe used forthepurposes of the Contract until it has been approved in place of the earlier issue of the drawing.

The Employer shall arrange to send observations if necessary within 28 (twenty

eight) calendar daysof submission of the design and drawings for modifications to the Contractor. The Contractor shall incorporateallnecessarycommentsoftheEngineerintheabovedesignanddrawings,if any,andshall re-submit further 5 (five) copies each (Hard copy & Soft copy) of the revised designs and drawings within10(ten) daysforfinal approval oftheEngineer.TheContractorshall thereaftersubmit 8(eight)

copieseachoftheapproveddesignsand8(eight)copieseachoftheapproveddrawingst ogetherwith one copy each of the reproducible tracings. The Engineer will return 2 (two) approved copies to the Contractor and retain 6 (six) for the Engineer’s office and field use.

Ifthesubmissionsrequiremorethenoneroundofrevisiononaccountofincompletecom pliancefrom Contractor, the delay will be on account of the Contractor. If new observations are given by the Engineer, the Contractor will be entitled to take an additional 10 (ten) days period for compliance.

TheEngineerwillsignifyhisapprovalordisapprovaloftheP reliminaryPhaseDrawi ngs/ Construction Documents within 28 (twenty eight) calendar days of each submission.

Thestructuraldesignsshallbesubmittedalongwith STAADfiles(inputandoutput).
The Construction Documents are certified Drawings submitted by the Contractor to the Employer or EngineerduringthecourseoftheContractforapproval.ConstructionDocumentsshallbesu bmittedin accordance with the timetable set down in the Work Programme.

ApprovalofdrawingsbytheEngineershallnotbeheldtorelievetheContractorofhisres ponsibilities under the Contract.

Theconstructiondrawingsshallbesubmitted inA3/ A1sizeddrawingpapersandtoreadablescale.

TheEngineerwillnotpermitconstructiontostartonapartorsectionoftheWorksunle ss Construction Documents for that part or section have been approved.

DraftcopiesoftheO&MManualsshallbesubmittedtotheEngineerforhisapproval atleast56 (fifty six) calendar days prior to the commencement of Tests on Completion.

TheEngineerwillsignifyhisapprovalordisapprovaloftheO&MManualswithin28(twentyei ght) calendar days of submission.

DraftAs-BuiltDrawingsshallbesubmitted56calendardayspriortothecommencementofTestson Completion.

TheEngineerwillsignifyhisapprovalordisapprovaloftheAs-BuiltDrawingswithin28(twenty- eight) calendar days of submission.

TheFinalAs-BuiltDrawingsshallbesubmittedpriortotheissueofanyTakingOverCertificate.

Toremovedoubtthesubmissiondatesreferredtoaboveshallbethedatesonwhichthedrawingsand documents are received by the Engineer.

Noticeof Operations

TheContractorshallgivefullandcompletewrittennoticeofallimportantoperationstotheEngineer sufficiently in advance to enable the Engineer to make such arrangements as the Engineer may consider necessary for inspection and for any other purpose. The Contractor shall not start any important operation without the written approval of the Engineer.

Protectionof Existing Installations

The Contractor shall apply to the Engineer in writing at least 28 days before starting any work that involvesinterferencewithexistingstructures,equipment,etc.TheContractorshallnotexecutesuch work until he has received permission to proceed, in writing from the Engineer.

The Contractor shall ensure that no earth, debris or rock is deposited on public or private roads or rightsofwayasaresultoftheWorksandallvehiclesleavingtheSiteshallbecleanedaccordingly.

ProtectionofExistingPublicandPrivateServices

TheContractorshallnotifyallpublicauthorities,utilitycompaniesandprivateownersofproposed works that will affect them not less than two weeks before commencing the works.

TheContractorshalladequatelyprotect,uphold,maintainandpreventdamagetoallse

rvicesandshall not interfere with their operation without the prior consent of the public authorities, utilitycompanies, private owners, or the Engineer as appropriate.

IfanydamagetoservicesresultsfromtheexecutionoftheWorks,theContractorshallimmediately:

(a) NotifytheEngineerandappropriatepublicauthority,utilitycompanyorprivateowner.

(b) Make arrangements for the damage to be made good without delay to the satisfaction of the public authorities, utility company or private owner as appropriate. The Contractor shall be liable for all costs for making good such damage.

TheEngineermayissueinstructionsormakeothersucharrangementsashedeemsnecessary,torepair rapidly any essential services damaged during the execution of the Contract. Such arrangements shall not affect any liability to pay for making good the damage.

ReinstatementandCompensationforDamagetoPersonsor Property

The Contractor shall reinstate all properties whether public or private which are damaged in consequenceoftheconstructionandmaintenanceoftheWorkstoaconditionasspecifiedandatleast equal to that obtaining before his first entry on them.

IfintheopinionoftheEngineertheContractorshallhavefailedtotakereasonableandpromptaction to discharge his obligations in the matter of reinstatement,the Engineer will informthe Contractor in writingofhisopinion,inwhichcircumstancestheEmployer reservestheright toemployotherstodo the necessary work of reinstatement and to deduct the cost thereof as certified by the Engineer from any money due or which shall become due from the Employer to the Contractor.

TheContractorshallrefertotheEmployerwithoutdelayallclaims,whichmaybeconsideredtofall within the exceptions listed in the Conditions of Contract.

PackingandProtection

Before any Plant is despatched from a manufacturer's factory it shall be adequately protected and

packedtoensurethatitwillarriveontheSiteinanundamagedcondition.Themethodse
mployedfor protection and packing must be suitable for withstanding the
conditions which may be experienced duringshipment, deliveryto the Site
andprolonged periods of storage inthe open,whether the items
areshippedinpackingcases,cratesoronlypartiallyprotectedaccordingtotheir nature.

Bright parts and bearing surfaces shall be protected from corrosion by applying a rust preventive lacquer,highmeltingpointgreaseorsimilartemporaryprotection.Asufficientquantityofsolvent shall be supplied with the plant to enable this coating to be removed on the Site.

Allmachinedflangesandothermatingsurfacesshallbeprotectedbymeansofwoodtemplates.The bolts for securing these templates shall not be reused in the final installation.

NoonecrateorpackageshallcontainitemsofPlantintendedforincorporationinmorethanonepart of the Works.

AllitemsofPlantshallbeclearlymarkedforidentificationagainstthepackinglist,which shallbe placed in a waterproof envelope inside every packing case or crate.

Everypackingcaseandcrateshallbeindeliblymarkedtoshowitsweight,serialnumber,topand bottom, shipping marks and handling instructions or sling marks.

ElectricalPlantshallbeenclosedinsealedairtightpackageswithdehydratingmaterial,beforebeing placed in packing cases on shock-absorbent material and secured by means of battens.

QualityAssurance

Policy

In accordance with Clause 4.9of the Conditions of Contract the Contractor shall apply the formal requirementsofQualityAssurancetothedesign,supply,constructionandmaintenanceoftheWorks. This shall be achieved through the implementation of a Quality System compliant with the requirements of BS 5750 or an equivalent International Standard.

PositivecommitmenttoQualityAssuranceshallbeexpressedinaformalpolicystatementgiveninthe Contractor's Quality Manual.

Objectives

ItshallbethestatedaimoftheContractortoachieveanddemonstratetheachievement ofqualityas expressed by `due care and diligence' of the design, supply, construction and maintenance of the Works as defined by the Employer's Requirements.

Thecriteriatodefine`duecareanddiligence'shallbeexplainedintheContractor'sQuality Planand shall embody all of the design, supply, construction and maintenance requirements of the Works.

QualitySystem

TheQualitySystemshallbefullyintegratedforallofthe Works.

Thissystemwillbedefinedbytheorganisationalstructure,responsibilities,activities,resources,and events that together demonstrate the capability of the Contractor to meet the stated quality requirements.

TheContractorshallensurethatallSub-Contractorsandsub-consultantsestablishqualitysystemsand shall supply to the Employer such evidence as is necessary to demonstrate the effective implementation of a quality system in each sub-contractor or sub-consultant organisation.

TheQualitySystemoftheContractorandofhisSub-Contractorandsub-consultantswillbesubjectto periodic audits undertaken by the Engineer. The Engineer will give two weeks' notice of such audits that will involve a full assessment of the performance and efficiency of the Quality System and will include review of the feedback and records derived from the Contractor's monitoring and internal reviews.

Onaday-to-daybasistheContractorshallaffordreasonableavailabilityofstaffanddocumentationfor the Engineer to assess the implementation of the Quality System. The Contractor shall ensure that all relevant personnel and documentation are available for such audits.

QualityPlan

TheimplementationoftheQualitySystemshallbethroughtheestablishmentofacompr
ehensive Quality Plan issued to and approved by the Engineer.

Thedocumentedproceduresshallincludebutnotbelimitedto:

- ManagementProcedures.
- Design.
- Supply/Procurement.
- Construction.
- Puttingtowork/Commissioning/ReliabilityTrial/ PerformanceTestwitnessingthetestand review.
- OperatorTrainingandMaintenance.
- InterfaceControl.
- QualityPerformance,MonitoringandReview.

Thereshallbeprocedurestocontroltransmissionofinformationacrossallinterfacesbothinternally (that is, within the Contractor's Quality System) and externally. Those of the latter shall include all Statutory Bodies, Authorities and the Engineer.

Formal assessment of any non-compliance with the Quality Plan shall be achieved through periodic reviews undertaken by a team appointed by the Contractor. All deficiencies shall be recorded and appropriatecorrectivemeasuresshallbeassessed,withinanappropriatetimescale,throughsubsequent formal reviews undertaken by the Contractor.

QualityFeedback

Thesystemshallincludeforthereportingback,recordingandincorporationintothesystemof deficiencies and remedial measures to correct them noted during the control of the project.

EnvironmentalProtection

TheContractorshallminimize,asfarasispracticallypossible,theeffectsofallhisandhisSubcontractor’s activities upon the environment and shall implement and monitor measures to prevent:

(a) Contaminationofsurfaces,ground,groundwater,surfacewaterandrivers.
(b) Emissionstoair,includingsmells,gases,smokeand dust.
(c) Unsanitaryorunsafestorageordischargetodrain,sewerandsurfacewaters.
(d) Unsanitaryorunsafestorageordischargeofsolidwastes.
(e) Noise.
(f) Visualintrusionand
(g) Excessiveenergyandwaterconsumption.

Theserequirementsshallbemetthroughtheconstantandcarefulattentionofthe Contractor's managementofall Site and off-site activities, and by instruction to all staff and labour in these matters.

Implementation shall include for monitoring and reporting on the results of the above measures. Monitoring reports shall be in writing and submitted on a monthly basis as part of the monthly report referred to above. The report shall include a listing and summary of daily monitoring results on all aspects listed above.

Allpotentiallyaffectedareasofthe Site,otherareasused fororaffectedbythe worksand alladjacentoraffected waterways shall be monitored and, where instructed by the Engineer, tested.

Safety

The Contractor shall prepare a Safety Plan and submit the same to the Engineer for approval within 28 days of receiving the Notice to Commence.

The Safety Plan shall be followed at all times by the Contractor and shall contain adequate control measures, in accordance with the relevant protection of property and local laws and regulations as well as internationally accepted good practice, for the prevention of accidents, fires and public nuisance.

The Safety Plan shall be implemented properly and diligently throughout the execution of the Works and during the operations and maintenance period.

TheContractor'sSafetyPlanshallmakesafetyprovisionfor,amongotherthings:

(a) Deepexcavationsandcollapsingsidesintrenchexcavations.
(b) Scaffoldsandoverheadworking.
(c) Workinginconfinedspaces.
(d) Workinginwater.
(e) Contractor'sEquipment,especiallycranes,heavyvehicles,etc.
(f) Handheldpowertools.
(g) Electricalequipment,powerconnection.
(h) Hazardouschemicals,gasesandfuels.
(i) Theuseofprotectiveclothingand
(j) Theprovisionoffirstaid facilities.

On-SitePatrol

- TheSafetyManagerpatrolseveryday(preparationofreport&announcementin morning meeting)
- SurpriseinspectionbyEngineer
- Regularsafetyexercise
- Morningmeetingevery day

- The Contractor shall at all times in the conduct of his work and that of his Subcontractors adhere to the established rules and regulations concerning all safety matters at Site such as the recommendations contained in the "Manual of Accident PreventioninConstruction",publishedbytheAssociatedGeneralContr

America, Inc., or other Internationally recognized recommendations to the extentthat such provisions do not conflict with the applicable laws.This is especially important wherever it is necessary to enable the free passage of the public through the Site.

The Safety Plan shall be developed to ensure zero fatal accidents and zero hazardous incidents/occurrences in all construction works. The Safety Plan shall include descriptions of the company's standard policies and procedures regarding its site organization and procedures, methods andfrequencyofconductingsafetyauditsattheSite(s),recordkeepingandreporting,providingsafety trainingforits personnel(includingsubcontractors),issue and mandatoryuseofsafetyequipment, and details of the qualifications and experience of the Bidder's proposed safety officers to be deployed at the Site(s). The Contractor shall provide separate descriptions in its Safety Plan covering the construction phase and the subsequent operations and maintenance phase.

- TheContractorshallappointafulltime Expert/ HealthandSafetyEngineer/Manager (Accident Prevention Officer) having the required qualifications and experience in thisfield,whoshallberesponsibleforimplementingtheSafetyPlan.Hes houldhave the authority to issue instructions to the Contractor's personnel regarding protection measures to prevent accidents.

- The Contractor shall provide the public with adequate information on all risks with respect to the construction works. If the general public sustains any kind of bodily injury or death, the Contractor shall be responsible for providing all necessary medical care and compensation.

The Contractor shall ensure that his staff and labour and his Subcontractors are all fully trained in and aware of good and safe working practices.

The Contractor shall ensure that all precautions are taken to safeguard the general public and construction/operating staff from any danger.

- During construction the Contractor shall erect, maintain and subsequently remove sufficient barricades, guards, lighting, sheeting, shoring, temporary sidewalks and bridges, danger signals as well as temporary covering of potential accident areas, as approved by the Employer. All temporary and partially completed works shall be protected by way of barriers, lights, notices and the like. All excavations and the like are to be protected by barriers at all times and adequately illuminated at night. Adequate number of Life buoys are to be provided near water retaining structures with depth more than 1.2m during construction and Operation & Maintenance stage.

- All open excavations along pipe lines shall be protected sufficiently to keep out livestock, and ensure the safety of workmen and members of the public and be in accordance with the directives of the police and the other local regulations.

- The Contractor shall be responsible for ensuring that all persons working in the vicinity of power lines are aware of the relatively large distance that high voltage electricity can "short" to earth when cranes or other large masses of steel are in the vicinity of power lines.

- Where work is to be carried out in the proximity of buildings, bridges, tanks or other structures, the Contractor shall take all necessary precautions, including shoring and strutting, where necessary, to ensure the safety of the structures that are at risk.
- The Contractor shall be responsible for all damages or injury which may be caused on any property by trespass by the Contractor's or his Subcontractor's employees in the course of their employment, whether the said trespass was committed with or without the consent or knowledge of the Contractor.

Warning and diversion signs concerning roadwork shall be suitably placed to give motorists ample warning. Duringthe movementofheavyvehiclesacrossroadsoronto roads,men,bearingred flags,shallbeinattendance to warn other road users and to generally control traffic in a safe manner.

The Safety Plan shall also consider requirements for warning and protection for other risks including overhead and underground cables, pipes or obstructions, or voids, openings, pits and trenches. The Contractor shall ensure that all appropriate measures are implemented.

1. Suitable scaffolds should be provided for workmen for all works that cannot safely be done from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used an extra mazdoor shall be engaged for holding the ladder andiftheladder isused forcarryingmaterialsas well suitable footholds and hand-hold shall be provided on the ladder and the ladder shall be given an inclination not steeper than ¼ to 1 (¼ horizontal and 1 vertical).
2. Scaffolding of staging more than 3.6 mabove the ground or floor, swung or suspended from an overhead support or erected with stationary support shall have a guard rail properly attached or bolted, braced and otherwise secured at least 90 cm. high above the floor, or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.
3. Workingplatforms,gangwaysandstairwaysshouldbesoconstructedthatthey shouldnotsag unduly or unequally, and if the height of the platform or the gangway or the stairway is more than 3.6 m above ground level or floor level, they should be closely boarded; should have adequate width and should be suitably fastened as described in (2) above.
4. Every opening in the floor of a building or in a working platform shall be provided with suitable means to prevent the fall of person or materials by providing suitable fencing or railing whose minimum height shall be 90 cm.
5. Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m. in length while the width between side rails in rung ladder shall in no case be less than 29 cm. forladder up to and including 3 m. in length. For longer ladders this width should be increased at least6 mmfor each additional30cm. oflength.

Uniformstepspacingof not more than30cm shall be kept. Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites or work shall be so stacked or placed as to cause danger or inconvenience to any person or the public. The contractor shall provide allnecessaryfencingandlightstoprotectthepublicfromaccident.TheContractorshallbe

bound to bear the expenses of defence of every suit, action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and cost which may be awarded in any such suit, action or proceedings to any such person.

6. Excavation and Trenching - All trenches 1.2 m. or more in depth, shall always be supplied with at least one ladder for each 30 m. in length or fraction thereof. Ladder shall extend from bottom of the trench to at least 90 cm. above the surface of the ground. The sides of the trenches which are 1.5 m. or more in depth shall be stepped back to give suitable slope or securely held by timber bracing, so as to avoid the danger of sides collapsing. The excavated materials shall not be placed within 1.5 m. of the edges of the trench or half of the depth ofthe trench whichever is more. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.
7. Demolition - Before any demolition work is commenced and also during the progress of the Work,
    i) All roads and open areas adjacent to the work site shall either be closed or suitably protected.
    ii) No electric cable or apparatus which is liable to be a source of danger or cable or apparatus used by the operator shall remain electrically charged.
    iii) All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.
8. All necessary personal safety equipment as considered adequate by the Employer should be kept available for the use of the person employed on the site and maintained in a condition suitable for immediate use, and the contractor should take adequate steps to ensure proper use of equipment by those concerned.

Thefollowingsafetyequipmentshallinvariablybeprovided.

i) Workers employed on mixing asphalt materials, cement and lime mortars shall be provided with protective footwear and protective goggles.

ii) Those engaged in white washing and mixing or stacking of cement bags or any material which is injurious to the eyes shall be provided with protective goggles and nose masks.

iii) Those engaged in welding works shall be-provided with welder’s protective eye Shields, nose mask & gloves.

iv) Stone breaker shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.

v) When workers are employed in sewers and manholes, which are in active use, the contractors shall ensure that the manhole covers

are opened and ventilated atleastfor an hour before the workers are allowed to get into the manholes, and the manholessoopenedshallbecordonedoffwithsuitablerailingandprovided with

warning signals or boards to prevent accident to the public, in addition, thecontractor shall ensure that the following safety measures are adhered to:

a) Entry for workers into the line shall not be allowed except under supervision of the Engineer.

b) At least 5 to 6 manholes upstream and downstream should be kept open for at least 2 to 3 hours before any man is allowed to enter into the manhole for working inside.

c) Before entry presence of Toxic gases should be tested by inserting wet lead acetate paper which changes colour in the presence of such gases and gives indication of their presence.

d) Presence of Oxygen should be verified by lowering a detector lamp into the manhole. In case, no Oxygen is found inside the sewer line, workers should be sent only with Oxygen kit and self-contained breathing apparatus (SCBA).

e) Double lanyard safety harness with shock absorber and rope should be provided to the workers. While working inside the manholes such rope should be handled by two men standing outside with pulley system to enable him to be pulled out during emergency conditions.

f) The area should be barricaded or cordoned off by suitable means to avoid mishaps of any kind. Proper warning signs should be displayed for the safety of the public whenever cleaning works are undertaken during night or day.

g) No smoking or open flames shall be allowed near the blocked manhole being cleaned.

h) The malba (solid waste) obtained on account of cleaning of blocked manholes and sewerlines should beimmediatelyremoved toavoidaccidentsonaccountof slippery nature of the malba.

i) Workers should not be allowed to work inside the manhole continuously. He should be given rest intermittently. The Engineer may decide the time up to which a worker may be allowed to work continuously inside the manhole.

j) Self-containedbreathing apparatus(SCBA) and first aid should always bepresent at site for use in any emergency.

k) Air-blowers should be used for flow of fresh air through the manholes.Whenever called for portable air blowers are recommended for ventilating the manholes. The Motors for these shall be vapour proof and of totally enclosed type. Non sparking gas engines also could be used but they should be placed at least 2 meters away from the opening and on the leeward side protected from wind so that they will not be a source of friction on any inflammable gas that might be

present.

l) The workers engaged for cleaning the manholes/sewers should be properly trained in “Confined Space” before allowing working in the manhole.

m) The workers shall be provided with Gumboots or non sparking shoes bump helmets and gloves non sparking tools safety lights and gas masks and portable air blowers (when necessary). They must be supplied with barrier cream for anointing the limbs before working inside the sewer lines.

n) Workmen descendinga manholeshalltryeachladderstop or rungcareful before putting his full weight on it to guard against insecure fastening due to corrosion of the rung fixed to manhole well.

o) If a man has received a physical injury, he should be brought out of the sewer immediately and adequate medical aid should be provided to him.

p) The extent to which these precautions are to be taken depend on individual situation but the decision of the Engineer regarding the steps to be taken in this regard in an individual case will be final.

vi) Contractor shall be fully responsible in the event of death of employee/workmen during the execution of the work and liable to pay adequate compensation to the dependants of employee/workmen as per law. On his/their failure, if the Board is made to pay compensation the same shall be recovered by the Board from the contractor out of the amount due to the contractor or by appropriate legal action. If death of any employee occurs during execution of work due to negligence of contractor, the contract may be liable for termination .The Board will be entitled to claim exemplary damages from the contractor in case of death of any workman/employees of the contractor in any of the BWSSB works as it damage the reputation of the Board.

vii) The Contractor shall not employ men and women below the age of 18 years on the work of painting with products containing lead in any form. Wherever men abovethe age of 18 are employed on the work of lead painting, the following precaution should be taken:-

a) No paint containing lead or lead products shall be used except in the form of paste or readymade paint.

b) Suitable face masks should be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint is dry rubbed and scraped.

c) Overalls shall be supplied by the contractors to the workmen and adequate facilities shall be provided to enable the working painters to wash during and on the cessation of work

d) Whitelead,sulphateofleadorproductcontainingthispigment,shall notbeused in painting operation except in the form of pastes or paint ready for use.

i) Measures shall be taken, wherever required in order to prevent dangerarising from the application of paint in the

form of spray.

ii) Measures shall be taken, wherever practicable, to prevent danger arising out of from dust caused by dry rubbing down and scraping.

iii) Adequate facilities shall be provided to enable working painters to wash during and on cessation of work.

iv) Overalls shall be worn by working painters during the whole of working period.

v) Suitable arrangement shall be made to prevent clothing put off during working hours being spoiled by painting materials.

vi) Cases of lead poisoning and suspected lead poisoning shall be notified and shall be subsequently verified by medical man appointed by competent authority of BWSSB.

vii) BWSSB may require when necessary medical examination of workers including measuring blood lead levels.

viii) Instructions with regard to special hygienic precautions to be taken in the painting.

9. When the work is done near any place where there is risk of drowning, all necessary equipment should be provided and kept ready for use and all necessary steps taken forprompt rescue of any person in danger and adequate provision, should be made for prompt first aid treatment of all injuries likely to be obtained during the work.

10. Use ofhoistingmachinesandtackleincludingtheirattachments,anchorageandsupportsshall conform to the following standards or conditions:

i. These shall be of good mechanical construction, sound materials and adequate strength and free from patent defects and shall be kept repaired and in good working order.

ii. Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength, and free from patent detects.

iii. Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years should be in charge of any hoisting machine including any scaffolding winch or give signals to operator.

iv. In case of every hoisting machine and of every chain ring hook, shackle swivel and pulley block used in hoisting or as means of suspension, the safe working load shall be ascertained byadequate means. Every hoisting machine referred to above shall be plainly marked with the safe working load. In case of a hoisting machine having a variable safe working load each safe working load and the condition under which itis applicable shall be clearly indicated. No part of any machine or any gear referredto above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.

v. The Contractors shall notify the safe working load of the machine to the Employer- in-chargewheneverhebringsanymachinerytositeofworkandgetitverifie

dbythe Electrical Employer concerned.

11. Motors, gearing, transmission, electric wiring and other dangerous parts of

hoistingappliancesshouldbeprovidedwithefficientsafeguards.Hoistingappliancesshouldbe

provided with such means as will reduce to the minimum risk of accidental descent of the load. Adequate precautions should be taken to reduce to the minimum risk of any part of a suspended load becoming accidentally displaced. When workers are employed on electrical installations, which are already energized, insulating mats, wearing apparel, such as. Gloves, sleeves and boots as may be necessary should be provided. The worker should not wear any rings, watches and carry keys or other materials, which are good conductors of electricity.

All scaffolds, ladders and other safety devices mentioned or described herein shall be maintainedinsafeconditionandnoscaffold,ladderorequipmentshallbealtered orremoved while it is in use. Adequate washing facilities should be provided at or near places of work.

12. These safety provisions should be brought to the notice of all concerned by display ona notice board at a prominent place at work spot. The person responsible for compliance of the safety code shall be named therein by the contractor.
13. To ensure effective enforcement of the rules and regulations relating to safety precautions the arrangements made by the contractor shall be open to inspection by the Labour Officer or Employer-in-Charge of the department or their representatives.
14. Notwithstanding the above Clauses from (1) to (13) there is nothing in these to exempt the contractor from the operations of any other Act or Rule in force In the Republic of India.

AdditionalSafetyGuidelines

Followingguideline/instructionsshouldbeadheredtointruespirit:-

1. The door may be fixed at the entry of the stair case and the open portion of the stair case of sump well should be protected by grill up to the height of 7 feet and compartments of the sump well should be covered with jallis/grating or should be barricaded property. Sewage pumping station should be secured by providing and fixing barbed wire fencing over the boundary wall.
2. An inspection register should be placed at the sewage pump house in which all the inspecting officers may record their observations. No unauthorized entry should be allowed.
3. Caution board showing the restricted entry area and name of components and moving mechanical part should be displayed.
4. The entry to all BWSSB infrastructures should be restricted to the person /persons authorized by BWSSB or having I.D cards issued by the chief security officer.
5. Just after entering the premises do’s and don’ts should be displayed at prominent places in all three languages.

6. Even authorized visitors should beprovidedproper uniform/visitorbadges helmet and relevant safety gear and given instruction before showing such infrastructure.

Nopersonbelow18yearsageshouldbeallowedonthepremiseswherechancesofemission oftoxic gases are extensive.

NationalHuman RightsCommission(NHRC)Guidelines

NHRC issued guidelines on safety code for operation/maintenance of sewerage system has to be strictlyfollowedduringexecutionofwork.DirectiongivenbyHon'bleSupremeCourtin thematterof National Campaign for Dignity & Right of Sewerage & Allied workers.

1. The medical examination and medical treatment will be given free of charge to sewer workersand the treatment will continue for all such workers found to be suffering from an occupational disease, ailment or accident until the workman is cured or until death.
2. The services of the sewer workers are not to be terminated, either by the respondents or the contractors engaged by them during the period of illness and they shall be treated as if on dutyand will be paid their wages.
3. The respondents shall pay on the death of any worker including any contract worker, an immediate ex-gratia solatium of One lakh with liberty to recover the same from contractors, if permissible in law.
4. The respondents shall pay/insure payment of all statutory dues such as Provident Fund, Gratuity and Bonus to all the sewer workers including contract workers, as applicable in law.
5. The respondents shall provide as soon as possible modern protective equipment to all the sewer workers in consultation with the petitioner organization.
6. The respondents shall provide soap and oil to all the workmen according to the present quota but on monthly basis and not at the end of the year.
7. The respondents shall provide all workmen including contract workmen with an accident-card- cum-wage-slip.

ProtectionofOverheadandUnderground Services

- The Contractor will be held responsible for any damage to known services (i.e. overhead services that are visible within the Site and undergroundservices shownon the drawings) and he shall take all necessary measures to protect them. All work or protective measures shall be subject to approval of the Employer. In the event of a service being damaged he shall inform the Employer and the authority concerned,the Contractor shall not repair any such service unless instructed to do so.
- Contractor will map the underground utilities. Where no underground services are shown on the drawings or scheduled but the possibility of their presence can reasonably be inferred, the Contractor shall, in collaboration with the Employer, ascertain whether any such services exist within the relevant section of the Site. The Contractor shall complete such an investigation well in advance of the start of construction work in the said section and he shall submit a report in good time to enable the Employer to take necessary actions.
- In main roads andjunctions, irrespective of utilityservices

indicatedin the drawing, the Contractor need to take proper care prior to commencement of Construction activities so as to ensure minimum disruption to the services. This may require even making a cross sectional trail pit to determine the exact alignments of different utilities.

- Taking care of other utility services infrastructure during the execution of the works is the responsibility of the Contractor. Nothing in the Contract should relieve the Contractor from his responsibility towards safety of other utility services infrastructure during project execution. The Contractor's Construction program should include such activities into consideration and no extra claim towards time of completion and cost in this regard shall be entertained.
- As soon as any underground service not shown on the drawings is discovered, itshall be deemed to be a known service and the Contractor will be held responsiblefor any subsequent damage to it.
- Where the authority concerned elects to carry out on its own account any alterations or protectivemeasures,theContractor shall co-operatewithandallowsuchauthority reasonable access and sufficient space and time to carry out the required work.

The Safety Plan shall include a policy statement signed by the CEO or equivalent authority of the Organizationdeclaringthatsafetyandlosspreventionshallbegiventhehighestpracticableprioritynin all aspects of the Contract.The Safety Plan shall be updated as necessary to cover the activities to be undertaken for operations and maintenance.

EndofPart-3

PART 4

GENERALWORKMANSHIP,MATERIALANDDESIGNREQUIREMENTS FOR PLANT

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PART-4

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PART4

GENERALWORKMANSHIP,MATERIALANDDESIGNREQUIREMENTSFORPLANT

Introduction

This part of the Employer's Requirements sets out the standards of materials, workmanship and designtobeusedbytheContractorforPlant.Referencetoanyspecificmaterialorequipmentdoesnot necessarilyimplythatsuchmaterialorequipmentistobeincludedintheWorks.

AllPlantusedfortheWorksshall,unlessotherwisespecified,complywiththeprovisionsofthispart.

The names of the manufacturers of materials and equipment proposed for incorporation in the Works together with performance, capacities, certified test reports and other significant information pertainingtothesame,shall befurnishedwhenrequestedforconsiderationbytheEngineer,whoshall have power to reject any parts which in his opinion are unsatisfactory or not in compliance with the Specifications and such parts shall be replaced by the Contractor at no extra cost to the Employer.

CompliancewithStandards

The British Standard specifications shall refer to the latest issue or revision of those standards as issued by the British Standards Institution of 2 Park Street, London W1 and the Indian Standard Specifications as issued by the Bureau of

Indian Standards.Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 001 and ASTM standards as issued by the American Society for Testing and Materials,1916,RaceStreet,Philadelphia,PA,19103,U.S.AandANSIstandardsasissuedbythe

American National Institute, 1430, Broadway, New York, NY 10018, U.S.A.Equipment conforming to other national or international standards shall be at least equivalent to those specified and shall be subject to approval bythe Engineer.Full details of the difference shall be supplied by the Contractor.

Where the design or choice of materials of plants is affected by the Factory Acts, then the materials and plant supplied shall comply with all relevant sections of those Acts even though no particular reference may be made in this Specification.

The Contractor shall obtain at least one copy of each IS, JIS, BS or other approved standards or reference material which are referred to in the Specification and a copy of all other standards which apply to materials which are being supplied to, or workmanship executed on the works. These standardsandreferencematerialshallbesuppliedtotheEmployer'sRepresentativew ithin90daysof the commencement date and will be available to the Contractor at all reasonable times.

Materials General

AllmaterialsincorporatedintheWorksshallbethemostsuitableforthedutyconcerne dandshall benew andoffirstclasscommercialquality,freefromimperfectionsand selected for longlife andminimummaintenance.

All submerged moving parts of the Plant, or the pins and spindles, etc., of the submerged moving parts or the faces etc.in contact withthem (water, sludge, waste water)shallbeofcorrosion resistantmetals.Allpartsindirectcontactwithvariouschemicals,shallbecompletel yresistant to corrosion, or abrasion by these chemicals, and shall also maintain their properties withoutaging dueto the passage of time, exposure to lightorany other cause. Where Mild steel is specified for submerged parts, the metal shall be protected by polyurethane coating.

Where "stainless steel" is specified or used itshall have resistance to atmospheric corrosion not less than thatprovided by Stainless Steel ASTM A 276 Gr. 410forforgings and BS EN 10293:2015, Grade 410-C-21 for castings.Particular attention shall be made to the prevention of seizure by fretting where two corrosion resistant metals are in contact,by the selection of materials of suitable relativehardnessandsurfacefinishandtheapplicationoflubricants.Wherebronzeiss pecified or used it shall be zinc free, to BS EN 1982:2017.

Particular attention shall be paid to the prevention of corrosion due to the close proximity of dissimilar metals.Whereitis necessaryto usedissimilar metals incontact, these shallbeselected sothatthe bimetalliccorrosionisas lowaspossible.The publication by H. M. Stationery Office(intheU.K.)entitled“CorrosionanditsPreventionatbimetallicContacts"shal lbeusedasa guide.

WorkmanshipGeneral

Workmanshipandgeneralfinishshallbeoffirstclasscommercialqualityandinaccordance withbest workshop practice and shall provide what is generally recognised as waterworks finish as defined elsewhere.

All similaritems of plantand theircomponent parts shallbe completelyinterchangeable.Spareparts shall bemanufacturedfromthesamematerialsastheoriginalsandshallfitallsimilaritemsof plant.Machining fits on renewable parts shall be accurate and to specified tolerances so that replacements made to manufacturer's drawings may be readily installed.

All equipment shall operate without excessive vibration and with minimum of noise.All revolving partsshall bedynamicallybalancedsothat whenrunningatall operatingspeedsandanyloadup to the maximumthere shall be no vibration due to lack of balance.

Allpartswhichcanbewornordamagedbydustshallbetotallyenclosedindustproofhousings.

Dynamicbalancingofrotarycomponentsshallbetotherelevantstandards.Allbearingsshallhave L-10 rating life of minimum 16,000 hours.

Allinstrumentsusedfortheworkswhetherforpermanentinstallationorforchecks/ inspectionat the Manufacturer'sworks or for checks/inspection atsite shallbecalibratedusingstandard reference instrumentsfrominstitutionsrecognisedbythe Government such as "Institute for Design ofElectrical Measuring Instruments (IDEMI), Mumbai.

Alloutdoorinstrumentsshallbeprovidedwithlocked,galvanisedmetallicenclosureso f2mm thickness, suitably painted.

DesignLife

All materials and equipment shall be designed forlonglifeand shall be suitable

for continuous 24 hourperdaysoperationforprolongedperiodswithaminimumof maintenanceandtheContractor

maybecalledupontodemonstratethisforanycomponenteitherbytheservicerecor dof similar equipment elsewhereorby records of extensive type tests.

Routinemaintenanceandrepairshallasfaraspossible,notrequiretheservicesofhighl yskilled personnel.

Except for consumable items such as rubber bushings, gland packings, carbon brushes etc.which normallyrequirereplacementmorefrequently,nopartsubjecttowearshallhavealifef romnewto replacementor repairof less than three years ofcontinuousnormal operationand where major dismantling isrequiredto replacea part, such life shall be not lessthanfifteen years.

Welding

Inallcaseswhere welds areliabletobehighly stressedthe Contractor shall supply tothe Engineer beforefabrication commences detailed drawings ofall welds and weld preparations proposed.NosuchweldingshallbecarriedoutbeforetheEngineerhassignifiedhisap provalofthe detailsproposed.Noalterationshallbemadetoanypreviouslyapproveddetailofweld preparation without prior approval of the Engineer.

WeldingshallcomplywithBSEN1011.

ApprovalofweldingproceduresshallbeasperBSENISO15614.Weldersshallbequ alifiedto BS EN 287-1:2004.All aspects of fabrication and examination proceduresincluding pre/post heatingtreatment, electrodes,non-destructiveTests(NDT) shallbesubject toapprovalofthe Engineer.

FollowingcodesshallapplyfortheNDTs:

BSEN 1435:1997: Radiography;

BSEN1714: 1998: UltrasonicTest;

BS 6072 & BS EN ISO 9934-1:2016:

MagneticParticleTest; BS EN ISO 3452-1: 2013:

Penetrant Test.

Castings

Allcastironshall beofstandardgreyclose-grainedqualitytoBSEN1561:2011/IS210Grade220 orbetterThe structure of the castings shall be homogeneous and free from non-metallicinclusions andotherinjurious defects.All surfaces of castings which are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.

Minordefectsnotexceeding12.5percentoftotalmetalthicknessandwhichwillnotultimatelyaffect the strength and serviceability of the casting may be repaired by approved welding techniques.The Engineer shall be notified of larger defects and no repair welding of such defects shall be carried out without prior approval.

Iftheremovalofmetalforrepairshouldreducethestressresistingcross-sectionofthecastingby 25percent,or tosuchanextentthatthecomputedstressintheremainingmetalexceedsthe allowablestress by more than 25 per cent,thenthat casting may be rejected.

Castingsrepairedbyweldingformajordefectsshallbestressrelievedaftersuchwelding.

Non-destructivetestswillberequiredforanycastingcontainingdefectswhoseextentcannot otherwisebe judged,orto determine that repair weldshavebeen properly made.

InstrumentComponents

Ironandsteelpartsshallingeneralbepaintedorgalvanisedasappropriateinaccordancewiththe Specification.Indoor parts may alternatively have chromium or copper-nickel plating or other approved protective finish.

Small ironand steel parts (other than stainless steel) of all instruments andelectrical equipment,the poles ofelectro-magnets and the metal parts ofrelaysand mechanisms shall be chromium or copper-nickelplatedorhavesomeotherapprovedfinishtopreventrustCores,etc.,whichare built up of laminations or cannotfor anyother reason be antirust treated, shallhaveall exposed parts thoroughly cleaned and heavily enamelled, lacquered or compounded.

Safeguardingof Machinery

TheContractorshallensurethatalldesignsandequipmentforwhichheisresponsiblea
resafe.Nothing
inthisRequirementshallremovetheContractorsobligationfromdrawingtheattentio
noftheEngineer
toanyfeatureoftheWorkswhichisnotconsistentwithsafety,ortopreventhimmakingp
roposalsfor
incorporatingequipmentordesignswhichwouldincreasethesafetyofthePlant.

Theinstallationlayoutandplantdesignshallnotallowanyitemofplanttobesoposition
edthatdanger
tooperatingpersonnelcouldariseduringnormaloperationandmaintenance.Particul
arattentionshall bepaidtothepositionof hot pipes,air
ventsandrotatingmachinery.

Allrotatingshafts,couplings,gears,flywheels,beltdrivesorothermovingpartsshallbe
fullyguarded.
Guardsshallbedesignedtoprovidereadyaccesstobearings,greasepoints,thermome
tersocketsand
othercheckpointsandtoallowsaferoutineobservationandservicingtobeexecutedwit
houttheneedto dismantle any part of their structure.

RatingPlates,Nameplatesand Labels

Allequipment,apparatusandPlantshallbeclearlylabelledorfittedwithnameplates
andratingplates generally as follows:

IndoorType Labels

(a) Labels for the outside of equipment shall be of a rigid type laminated and engraved plasticmaterial,withblackblockcapitalsonawhitebackground.Thela
belsshallbe fixed by non-rusting screws, or similar approved.
(b) Labellinginsideequipmentshallbeasaboveexceptthataflexibleself-
adhesivetype labellingmaybeusedifsuitablefortheambient
temperaturesandifnot lessthan12 mm in width.

WeatherproofLabels

Theselabelsmaybevitreousenamelledorbrass.Plasticlabelswillnotbeacceptedunle
ssproofcanbe
giventhatthelabelscanwithstandtheenvironmentalconditionsfoundatSite.

Vitreousenamelledlabelsshallbesecuredbybrassornon-rustingroundheadscrews,withbrassand fibrewashersincontactwiththeenamelfrontandbacktopreventdamage.

NameandRatingPlates

EachmainandauxiliaryitemofPlantshallhavepermanentlyattachedtoitinaconspicuouspositiona
nameplateandaratingplate.Uponthesehallbeengravedthemanufacturer'sname,typeandserial
numberofPlant,detailsoftheloadinganddutyatwhichtheitemofPlanthasbeendesignedtooperate,
andsuchdiagramsasmayberequiredbytheEngineer.Allindicatingandoperatingdevicesshallhave
securelyattachedtothemormarkeduponthemdesignationastotheirfunctionandpropermannerof
use.Provisionshallbemadetoincorporatedescriptivenumberingcodesasindicatedontheir Record
Drawings.Detailsofproposedplates,labelsandinscriptionsshallbesubmittedtotheEngineerfor approval before manufacture.

Lubrication

Acompletescheduleofrecommendedoilsandotherlubricantsshallbefurnishedbythecontractor.The
numberofdifferenttypesoflubricantsshallbekepttoaminimum.Thescheduleandthenameofthe
supplierofthelubricantsshallbesubmittedtotheEngineerforapprovalbeforeincorporationinthe
instructionmanuals.Inthecaseofgreaselubricatedrollertypebearingforelectricmotorslithiumbase grease is preferred.

Wherelubricationiseffectedbymeansofgrease,preferenceshallbegiventoapressuresystemwhich
doesnotrequirefrequentadjustmentofrecharging.Frequent,forthispurposemeansmorethanoncea
weekandgreasesystemshavingshorterperiodsbetweengreasingshouldbeavoided.Wherenecessary
foraccessibilitygreasenipplesshallbeplacedattheendoftheextensionpiping,and,whenanumberof
suchpointscanbegroupedconveniently,thenipplesshallbebroughttoacommonplacemountedina
convenientposition.Buttonheadtypenipplesshallbeusedfornormalgreaseandallgreasenipples
shallbeofthesamesizeandtypeforeverypartofthePlant.Arrangementsshallbeprovidedtoprevent bearings being overfilled with either grease or oil.

Wheremorethanonespecialgreaseisrequiredagreasegunforeachspecialtypeshallbesupplied and permanentlylabelled.

Oillubricatedbearingsshallbeprovidedwithanoilreservoircapableofautomatically maintainingthe correctoillevelwithinthebearings.Itmustnotbenecessarytoshutdownthepumpinorder to see the oil level or to add oil to the bearings.

Oilsumpsshallbefittedwithoillevelindicatorsofthesightglasstype,orwherethisisnotpracticable, withdipsticks.Theindicatorsshallshowthelevelatalltemperatureslikelytobeexperienced in

service.Thenormal,maximumandminimumlevelsat20°Cshallbeclearlyvisibleinthe sightglass
typefromthenormalaccessfloortotheparticularitemofplant,andtheyshallbeeasilydi smantledfor cleaning.

Allsightglassesshallbefirmlyheldandenclosedinmetalprotectioninsuchmannerth attheycannot be accidentally dislodged.

Alllubricationsystemsshallbedesignedsoasnottopresentafirehazardandparticular careshallbe
takentopreventleakageoflubricantsandtoavoidleakinglubricantscomingintoconta ctwithany electricalequipment,heatedsurfacesoranother potential sourceof fire.

TheContractorshallsupplyflushingoilforeachlubricationsystemwhenanitemofpl antisreadyfor
preliminaryrunningandasufficientquantityoftheapprovedlubricantsforsettingto workandforthe
commercialoperationofthePlantfortwoyearsaftertheTakingoverCertificatehasb eenissued.

InitialChargesofOilandGrease,etc.

Theinitialchargesofoil,grease,electrolyteandsimilarmaterialsnecessaryfortheco rrectsettingto
workandoperationofthePlantshallbeincludedintheappropriatePlantitem.

Non-metallicMaterials

Fabrics,cork,paperandsimilarmaterialswhicharenotsubsequentlytobeprotected byimpregnation
shallbetreated,withanapprovedfungicide.Sleevingandfabricstreatedwithlinsee doilvarnishwill not be permitted.

Theuseoforganicmaterialsshallbeavoidedasfaraspossiblebutwherethesehavet obeusedthey shall betreatedtomakethemfireresistantandnon-
flamepropagating.

Theuseofwoodshallbeavoidedasfaraspossible.Ifused,woodworkshallbethoroughly

seasoned teakorotherapprovedhardwoodwhichisresistanttofungaldecayandotherblemishes.Allwoodwork shallbetreatedtoprotectitagainstdamagebyfire,moisture,fungus,vermin,insect,bacteriaor chemicalattack,unlessitisnaturallyresistanttoallthese.Alljointsinwoodworkshallbedovetailedor tonguedandpinned.Metalfittingsonwoodshallbeofnon-ferrousmaterial.Adhesivesshallbe

speciallyselectedtoensuretheuseoftypeswhichareimpervioustomoistureandfungusgrowth. Synthetic resin cement shall be used for joining wood.

EngineeringHardware

Nuts,bolts,studsandwashersforincorporationintheWorksshallconformtotherequirementsofthe appropriateBritishorotherapprovedstandard.Nutsandboltsforpressurefittingsshallbeofthebest qualitysteel machined on the shankand under the head and nut.

Boltsshallbeofsuchalengththatonethreadshallshowthroughthenutwheninthefullytightened condition.

Fittedboltsshallbealightdrivingfitinthereamedholestheyoccupy,shallhavethescrewedportionof suchadiameterthatitwillnotbedamagedindrivingandshallbemarkedinaconspicuousspositionto ensure correct assembly at site.

Washers,lockingdevicesandanti-vibrationfittingsshallbeprovidedwherenecessarytoensurethatno bending stress is caused in the bolt.

Wherethereisariskofcorrosion,boltsandstudsshallbedesignedsothatthemaximumstressinthe boltdoesnotexceedhalftheyieldstressofthematerialunderallconditions.

AllsubmergedhardwareNuts,bolts,studs,washers,FastenersshallbeSS316material.

Allbolts,nutsandscrewswhicharesubjecttofrequentadjustmentorremovalinthecourseof maintenanceandrepair shall bemadeof nickel-bearing stainlesssteel.

TheContractorshallsupplyallholdingdown,alignmentandlevellingboltscompletewithanchorages, nuts,washersandpackingsrequiredtoattachthePlanttoitsfoundation,andallbedplates,framesand otherstructuralpartsnecessarytospreadtheloadstransmittedbythePlanttoconcrete foundations without exceeding the design stresses.

Unlessotherwisenecessarytomeetspecialrequirementsallthreadshallbeofprefer
redmetricsizes with standard coarse threads.

ISOmetricblackhexagonbolts,nutsandscrewsshallcomplywithSII0589-81,orISO885:2000,ISO 888:2018, ISO 898-1 and -2: 2013.

ISOmetricprecisionhexagonbolts,nutsandscrewsshallcomplywithISO272:1982,ISO 4759-1:2000,ISO885:2000,ISO888:2018,ISO898-1and-2:2018orASTMF-593,ASTMF-468 M,
strengthgrade8.8.

ThedimensionsofISOmetriccountersunkheadboltsscrews,andhexagonnutsshallcomplywithISO 225:2010, or ISO 888:2018, ISO 898-I.

PlainsteelwashersforusewithISOmetricboltsshallcomplywithISO887:2006orASTMF-844.

TapersteelwashersshallcomplywithASTMF-844andASTMF-436.

Instruments

Unlessotherwisespecified,anyindicatingandrecordinginstrumentssuppliedundertheContractshall beapprovedbytheEngineer.Theyshallbeflush-mountedpatternwithdust-and moisture-proofcovers andshallbesuitablefortheenvironmentinwhichtheyareinstalled.Wherehingedcoversare necessary, they shall be provided with locks.

Indicatinginstrumentsshallbeofthedialtypeandshallbeprovidedwithareadilyaccessiblezero adjustment.

Dialsingeneralshallbewhitewithblackmarkingsandnotsubjecttofading.Scalesshall beofsuch
materialthatnopeelingordiscolorationwilltakeplacewithageunderhumidconditions.

Motorammetersshallbecapableofwithstandingthestartingcurrentandshallhaveacompressed overload scale.

Steelscrews,whenused,shallbezinc,cadmiumorchromium-plated,orwhereplatingisnotpossible
duetotolerancelimitations,shallbeofstainlesssteel.Instrumentscrews(exceptthoseformingpartofa magneticcircuit)shallbeofbrassorbronze.Springsshallbenon-

rustingmaterials,egphosphor-bronze ornickel-silver,asfaraspossible.Pivotsandotherpartsforwhichnon-ferrousmaterialisunsuitable shall be of stainless steel.

Pressuregaugesshallbenotlessthat150mmdiameterunlessotherwiseapproved.The internal
componentsshallbeofstainlesssteel,bronzeorsomeothercorrosionresistantmaterialotherthan
aluminium.Thegaugesmaybemounteddirectlyonthepipeworkorsidebysideonaboardorpanel.
Eachpressuregaugeshallbefittedwithastopcockimmediatelyadjacenttothegauge,andallpressure
gaugepipingshallbefittedwithanisolatingvalveateachpointofconnectiontothemain system.
Wherepressuregaugesaremountedonpanels,theisolatingvalveshallbesuitablefortheconnectionof
atestgauge.Stopcocksofgaugesshallbeclearlyidentifiedbymeansofseparatelabels ofapproved type and lettering.

Allfixedpipesbelow25mmnominalboreshallbecompressionjointedheavygaugecopperwherethis
materialissuitable.Inothercasespipematerialsaretobeapprovedbytheengineer.All pressure
gaugesshallbefittedwithanairreleasecockandhydraulicpressuresnubberstoprotectthemagainst shockpressures.

PipingandEquipment Layout

Ingeneralallpipesandfittingsshallbesteelorductileironwithflangestobsen1092-1&2.

Wheresteelandcastflangesarematedtogetherthesteelflangeshallbemachinedoveritsfull face,after welding to its respective pipe is completed.

Flexiblejointsshallbeprovidedtofacilitateinstallationandremovaland/ ordifferentialmovementof
plant.Whererequired,flexiblejointsshallbeprovidedwithtieboltsorothermeanstotransfer longitudinal thrust along the pipework as a whole.

Thepipeworkshallbelaidoutanddesignedsuchastofacilitateitserection,paintinginsitu,dismantling
ofanysectionformaintenanceandtogiveaconstantanduniformflowofworkingfluidwitha
minimumlossinhead.Wheresteelpipeworkisusedthenumberofflangesistobekepttoaminimum
withthesizeofeachunitofpipeworkdeterminedbytheeaseofhandling,installationandgeneral

appearanceofthecompletedpipesystem.Positionsofflangesshalltakeintoaccountan
ynecessary concrete pipe supports or thrust blocks.

Facilitiesshallbeprovidedfordrainingthepipesystem.Whereapipepassesthrougha
wall,retaining
wallorissubjecttothrustitshallincorporateapuddleflangewhichshallconformtothed
imensions stated in BS EN 1092-1 but remain undrilled.

Unlessotherwisespecified,nuts,boltsandwashersforpipeworkshallconformtothere quirementsof BS EN 1092-1.

Boltsshallbeofsufficientlengththatonethreadshallshowthroughthenutwheninthefullyti ghtened condition.

Gasketsand Joint Rings

Jointringsshallbemanufacturedtoconformwith BS7874:1998, BSEN681-1:1996, BSEN681-2:2000, BSEN682:2002andshallbeofchloroprenerubberorotherapprovedsynthetic material suitable for temperatures up to 80°C.

Jointsshallbemadeinaccordancewithmanufacturer'sinstructionsorasspecifiedherein.

Untilimmediatelyrequiredforincorporationinajoint,eachrubberringorgasketshallb estoredinthe darkfreefromthedeleteriouseffectsofheatorcold,andkeptflatsoastopreventanypart oftherubber being in tension.

Onlylubricantsrecommendedbythe manufacturershallbeusedinconnectionwithrubberringsand theselubricantsshallnotcontainanyconstituentsolubleinwaterofthequalitystatedin the Requirements,shallbesuitablefortheclimaticconditionsattheSiteandshallcontaina napproved bactericide.

Aftercleaningtheflangesthegasketsshallbefittedsmoothlytotheflangeandthejoint madeby tighteningthenutstofingerpressurefirst.Thereafterthefinaltighteningofthenutssha llbemadeby graduallyandevenlytighteningboltsindiametricallyoppositepositionsusingstandar dspanners.

Graphitegreaseshallbeappliedtothethreadsofboltsbeforejointsaremade.

Steelwork

Anysmallareasofchequerplatingorsimilarcoveringthatarenecessarytocovergapsbetweenitemsof Plantandthesurroundingstructure,andanyaccessladders,platformsandhandrailsthatmustbe attachedtoitemsofPlanttofacilitateoperation,inspectionormaintenance,shallbesuppliedand erected by the Contractor.

TheContractorshallincludeinhisContractforprovidingadequatemeansofaccesstoallhandwheels, sightglasses,gauges,lubricationpointsandanyotheritemstowhichaccessisnecessaryforroutine maintenance.

Chequerplatingshallbeof`Durbar'orothernon-slippattern,notlessthan6.0mmthick(exclusiveof pattern)andhotdippedgalvanisedafterfabricationinaccordancewithBSENISO1461:2009.

Spareparts

TheContractorshallalsosupplythedetailsofrecommendedsparepartsandquantity requiredforthe continuousoperationoftheWorksforminimumperiodof7yearsasdetailedPriceSchedule.Thecost ofsparepartsshallnotbetakenforevaluation.ItshallnotbebindingontheEmployertobuyany/part ofthesparepartsrecommendedbythecontractor.Thesparepartsrequiredshallbedecidedpriorto Awardofcontractorduringtheexecutionofthecontract,whichshallbebindingonthecontractor.

Allsparepartsshallbenew,unusedandstrictlyinterchangeablewiththepartsforwhichtheyare intendedtobereplacementsandshallbetreatedandpackedforlongstorageundertheclimatic conditionsprevailingatthesite.Eachsparepartshallbeclearlymarkedorlabelledontheoutsideofits packingwithitsdescriptionandpurpose,andwhenmorethanonespareispackedinasinglecaseor othercontainer,ageneraldescriptionofitscontentsshallbeshownontheoutsideofsuchcaseor containerandadetailedlistenclosed.Allcases,containersandotherpackagesshallbemarkedand numbered in an approved manner for purposes of identification.

Allcases,containersorotherpackagesareliabletobeopenedforsuchexaminationastheEngineermay
requireandpackingsshallbedesignedtofacilitateopeningandthereafterrepacking.

"Spares,accompaniedbytechnicaldetails/
leafletsetc.,shallbedeliveredtositebeforethestartof
commissioningtests.Sparepartsshallbeindicatedintheassemblydrawingsofrespective plant items with clear details of part numbers.Contractorshallalso furnish the manufacturersrecommendations on spares for respective plant items."

Tools and test Equipments

The contractor shallsupplythedetailsofrecommendedspecialtoolsandtestequipmentrequiredto enableanyerection,dismantlingortestingtobecarriedoutonanypartofthePlant,whether ofan electrical,mechanicaloranyothernatureduringthelifeofthePlantandshallbelistedin thePrice Schedule.ThecostofToolsandTestequipmentshallnotbetakenforevaluation.Itshall notbebinding ontheEmployertobuyany/partofthetoolsandtestequipmentrecommendedbythecontractor.The toolsandtestingequipmentrequiredshallbedecidedpriortoawardofcontractordurin gtheexecution of the contract, which shall be bindingon the contractor.

Thetoolsandtestequipmentshallnotbeusedfortheerectionofthe Plantandexceptth attheEngineer maycalluponthe Contractortodemonstratetheiruseoreffectiveness,theymustbeha ndedovertothe Employerinacompletelynewandunusedcondition.ShouldtheContractorrequirean ysuchtoolsand test equipment at thesiteduringerection,heshall providehisown.

Thetoolsforeachdifferenttypeofequipmentshallbecontainedinasuitableboxclearly markedor labelledwithitsdescription.Eachtoolshallbeidentifiedandalistoftoolsshallbeaffixed totheinside oftheboxlid.Eachsetoftoolsshallbesuppliedwiththeequipmentwithwhichitisassoci ated.

Thetestequipmentshallincludeonlyspecialpurposeitemsessentialtothetestingorrec alibrationof related items of Plant.

Thetoolsprovidedshallincludeclamps,wrenches,liftinglugs,greaseguns,gauge stestrigs,jigsor extractorswhichmayberequiredforthelifeofPlant.Alltoolsandtestequipmentsh allbeclearly detailed with size/capacity etc.

ProtectionandPackagingfor Transportation

BeforeanyPlantisdespatchedfromamanufacturer'sworksitshallbeproperlypreparedandp acked.

PriortodespatchallPlantshallbeadequatelyprotectedbypaintingorbyotherapproved means for the whole period of, transit storages and erection, against corrosion and incidental damage, including the effects of vermin, sunlight, rain, high temperatures and humid atmospheres. The Contractor shall be held responsible for the Plant being so packed and/or protected as to ensure that it reaches the site intact and undamaged. The Plant shall be packed to withstand rough handling in transit and all packages shall be suitable for storage including possible delays in transit.

TheContractorshallbedeemedtohaveincludedintheScheduleofPricesforallmaterials andpacking casesnecessaryfor thesafepackage,conveyanceanddeliveryof thePlant.

Theflangesofpipes,valvesandfittingsshallbeprotectedbywoodendiscsattachedbymeansof servicebolts(whichshallnotbeusedatSite)orbyotherapprovedmeans.Thesleevesandflangesof flexiblecouplingsshallbebundledbywire.Casescontainingrubberrings,boltsandothersmallitems shall not normally weigh more that 500 kg gross.

NoonepackageorbundleshallcontainitemsofPlantintendedforincorporationinmore thanone section of the Works.

AllitemsofPlantshallbeclearlymarkedforidentificationagainstthepackinglist.

Everycrateorpackageshallcontainapackinglistinawaterproofenvelope.Aduplicate copyofthe packinglist shall be sent bypost to the Engineer at Site.

Allcrates,packages,etc.,shallbeclearlymarkedwithawaterproofmaterialtoshowtheweight,and wheretheslingsshouldbeattached,andshallalsohaveanindelibleidentificationmarkrelatingthemto the packing lists.

EndofPart-4

PART5

PROCESSREQUIREMENTS

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PART5

PROCESSREQUIREMENTS

IntermediateSewagePumpingStation(ISPS)

Process requirementsforthefollowingareincludedinthiscontractandaredescribedhereinPart 5 – “Process Requirements”

No.	Description	Ultimate Build out Design Average/PeakCapacity(MLD)	DischargesTo
1	IntermediateSewagePumping Station (ISPS) At Officers Quarters (HSR Layout)	14.5/45	35 MLD Agaram STP throughGravitymains.

TreatmentProcess

TheISPSshall consistofthemajorunit componentslisted inParagraph **Error! Referencesourcenot found.** – “**Error! Reference source not found.**”. This list shall not be considered to be a comprehensive description. Contractor shall provide a complete, fully functional facility designed for proper,easy,operationandtomeetthestatedperformancerequirements.Thisshallincludeanyandall additional, ancillary, supporting, or other processes, components, equipment, or other items necessary to achieve these objectives, regardless of whether such items are explicitly listed in these bid documents or not.

The design/sizing criteria, minimum number of units, and other requirements for the various unit processes and components are listed in Paragraph **Error! Reference source not found.** – “**Error! Referencesourcenotfound.**”,andinPart11–“GeneralandParticularMechanicalRequirements” and shall be fully complied.

PreliminaryPipingandInstrumentationDiagrams(P&IDs)fortheISPSisincludedinVolume3of these bid documents.

PlantLayoutandHydraulic Profile

ArepresentativelayoutandestimatedhydraulicprofileoftheISPSisincludedinVolume3ofthese bid documents.

Thesedrawingsshallbeconsideredrepresentativeonly.Intheeventofanyconflictsbetween information in the drawings and Part 5 – “Process Requirements”, shall govern.

BasicinformationaboutinletandoutlethydraulicconditionsfortheISPSisprovidedinParagraph **Error!Referencesourcenotfound.**–“**Error!Referencesourcenotfound.**”.

The Contractor shall ensure that the layouts and hydraulic profiles submitted as part of theContractor’sbidcomplywiththefollowingspecificconstraintsandallotherrequirementsdescribedin the Bid Documents:

- For all structures containing water or process liquid, the minimum freeboard (distance by which top of wall is higher than the maximum water surface level at receiving water highflood level and peak plant flow with one unit of each unit process out of service) shall be 0.5m unless specified otherwise.
- Contractor shall provide at ISPS all necessary facilities for manual bypass of the processliquid at various locations in the flow path as indicated below. These facilities are included in this contract and shall be provided regardless of whether or not they are shown in anydrawings included in the contract document, shall be fully functional in all respects, and shall include any and all components necessary to safely and efficiently accomplish the intended bypass. Each bypass facility shall include, but not be limited to: (i) downward opening overflow weir gates installed in the appropriate channel or structure from which the bypass is to be effected, (ii) an RCC channel or structure to receive the bypass flow over the weir gate,
  (iii) an appropriately sized buried (above ground piping will not be acceptable) RCC NP3 to carry the bypass flow from the channel or structure in (iv) an appropriately sized electro- magnetic flow meter along with all associated components and infrastructure to automatically measure and record details of all bypass events, including but not limited to date, start time, end time, continuous flow rate data for the entire

duration of the event, and a totalized volume for the event.

Bypassfacilitiesasdescribedaboveshallbeprovidedatthefollowinglocations:

- ISPSCoarseScreenEffluentChanneltonearestdrain

- Topographical survey information, benchmarks, contour maps, geotechnical/soil investigations, and effluent receiving water body high flood level (HFL) elevations for the ISPS are included with these bid documents and/or available from Employer on request. However, Employer and Engineer make no guarantees or representations whatsoeverregarding this information. Contractor's use of this information shall be at his own risk. Contractor shall independently obtain any and all site information necessary for proper planning, design, and operation of all components in the contract.

AllaspectsofContractor'stechnicaldesignshallalsobesubjecttoreviewandapproval byEmployer and Engineer.

PlantLayoutandOrientation

The ISPS components shall be laid out and fully contained within the respective designated site boundaries so as to logically interface with any and all existing infrastructure that may be present at thesiteandthat must remaininservice.Contractor'sproposedsitelayoutshallclearlyshow thespace allocated for all plant components, including those components and/or unit processes that may be designatedforfutureconstructionorinstallation.Setbacksandclearancesfromthesiteboundaryshall be provided as appropriate and as required by law. All existing utilities (including water, sewer, power, or others, whether overhead or underground and whether physically located on the site or not) requiringto be relocated toaccommodate the Contractor's proposedand approved site layout shall be relocated by the Contractor at no additional cost and without interrupting provision of such utility services to users and customers. Such relocations shall be fully coordinated with BWSSB.

Theplantlayoutshalladheretothefollowinggeneralrules:

- Minimum clear distance provided to permit safe and convenient access for operation and maintenance shall be 3 m between adjacent treatment units or fixed structures and 1 mbetween pieces of equipment
- An area adjacent to all mechanical equipment shall be provided as a maintenance lay down area
- All electrical equipment (except for motors) shall be located 300mm above the high floodlevel elevation for the site or for the effluent receiving water body, whichever is higher.

ModularDesign,Construction,andOperationforReliability,Redundancy, Turndown, and Easy Future Expansion

Theinitialdesigncapacityandtheultimatebuildoutdesigncapacityrequiredareboths pecifiedin Paragraphs **Error! Reference source not found.** 5.1 above for each ISPS.

TheISPS in thiscontractshallbe designedand constructedfor their fullrespectiveUltimate Buildout DesignCapacities,exceptthatthenumberofpumpsandmotorsshallbelimitedtothatn eededforthe Initial Design Capacity, with space reserved for additional future identically-sized units required to provide the full Ultimate Buildout Design Capacity.

Further, for all components under this contract, the capacity to be provided shall be designed and constructedusingmultiple,suitablysizedunitprocessmodulestoensurereliability,re dundancy,and appropriateturndownforoptimumcapacityutilisationandprocessefficiency.Themi nimumnumber ofworkingandstandbymodulesorunitsrequiredforeach component shallbeaslistedinParagraph **Error! Reference source not found.** – "**Error! Reference source not found.**".

GeneralDesignRequirements

Thefollowinggeneraldesignrequirements shallbemetforISPS.Theserequirementsshallbefully met regardless of whether or not such requirements or any related components are shown in any drawings included in the contract documents.

- TheContractorshallperformacompleteHazardousAreaClassificationanalysis per IS16724: 2018 & IS 5572 for ISPSs in this contract and shall submit a complete report of such analysis as well as Hazardous Area Classification Drawings that delineate boundaries of all classified areas and indicate the classification of each area. All electrical or other powered equipment, instrumentation, or components shall fully comply with all requirements of IS 16724: 2018.
- All components (including but not limited to equipment such as pumps, screens, inline devices; instruments such as flow meters; and distribution and collection channels or pipes) shall be provided with appropriate

isolation devices such as valves, gates, or other devices in order to allow isolation, drainage, cleaning, calibration, servicing, and maintenance of such components. Bypasses shall be provided around all flow meters and other in-line instrumentation such that the instrument can be isolated and removed for calibration and maintenance without interrupting the flow, regardless of whether or not such bypasses are shown in any drawings included in the contract documents.

- Where necessary, equipment shall be provided with acoustic, sound-dampening enclosures to limit ambient noise during normal operation to the limits detailed in the GeneralRequirements.
- All equipment shall be arranged and buildings and structures designed to permit safe and easy access to and removal of all equipment.
- Fixed runways, lifting eyes, cranes, hoists, or other appropriate devices and means shall be provided to permit safe and easy removal of all equipment for maintenance or any other purpose
- Allliquidorsludge flowdistribution shall beaccomplished usingoneofthe followingoptions only:
    - non-submerged (i.e. with a positive free fall from weir invert to the water surface on the downstream side) overflow weirs,
    - non-submergeddownwardopeningoverflowweirgates,or
    - Theautomaticstepcontrol,speedsynchronizationwithdutychangeov ersequences for eachfinal control element (Drives & Actuators) shall be implemented on PLC / SCADA System logic.
    - TheAuto-Jamremovalshallbeapplicableforeachscreensystemandthesameisto be implemented by using control logic built along with the screen control system which will going to be supplied by the Screen supplier. The Screen Control System data is to be integrated to ISPS SCADA / HMI System by using hard wired communication system.

  Anyothermeansofflowdistributionshallnotbe acceptable.

- The ISPS SCADA / HMIsystem, Instrumentation Control Panel (ICP) shall be installed inthe control room which is under Air Conditional environment (AC).
- All structures, whether liquid-holding or not, shall be designed such that they can be fully and completelydrainedandwill not float or move when empty, because of groundwater buoyancy or any other reason. The structures shall be designed to counteract any possible floatation without the use of any type of groundwater pressure relief valves.
- The floors of all liquid-holding structures shall be appropriately sloped and trenches and drain sumps shall be providedatthe bottoms of suchslopesto facilitatecomplete drainage ofliquid. Appropriate drain pipes and valves connected to the drain sump(s) shall be provided for all structures. Where the drain pipe connects to the structure, the top-of-pipe elevation shall be at least 150 mm lower than the lowest floor elevation for the structure.
- All concrete structures in contact with sewage and/or sludge shall be provided with interior corrosion protection linings and/or coatings of appropriate material and thickness – to be approved by Employer and Engineer. This also applies to all concrete structures in contactwith any

type of sewage/sludge anywhere in the plant.

- All channels carrying process liquid shall be fully covered with solid non-skid GRP cover plates (not grating) designed for human traffic live loads at a minimumand heavy vehicle live loads wherever the channel crosses traffic paths.
- Inlets into tanks, reactors, or other structures via pipes, channels, valves, or gates shall be designed such that the incoming flow does not cause any damage or excessive wear whatsoever to the structure or any equipment in the vicinity under any hydraulic condition, including but not limited to the condition when the structure is empty.
- All piping shall be of corrosion–resistant material appropriate for the service and shall be provided with interior lining, exterior coating, and other corrosion protection as appropriate. All piping shall be fully and adequately supported and braced to comply with all applicable codesand standards. All supportinghardwareshallalso be ofcorrosion-resistantmaterial.The design of pipe supports and anchors shall fully account for static and dynamic vertical, lateral, longitudinal, and seismic loads, fluid flow, and thermal expansion. Seismic bracing, thrust restraints and/or thrust blocks, and appropriate expansion joints or loops shall be provided as needed. Pipe lengths and joints shall be assembled and arranged for ease of removal in such a way that individual runs can be changed without dismantling adjacent pipes, by providing dismantling joints at regular intervals.
- For liquids and sludge, the minimum pipe flow velocity shall be no less than 0.6 m/s and the maximum pipe flow velocity shall be no more than 1.5 m/s for pumped suction and no more than 2.0 m/s for pumped discharge and the maximum pipe flow velocityshall be no more than 1.2m/sforgravity flow.
- Allliquidservicepipesshallbeprovided withappropriate meansforsafeandeasydrainage of the pipes when not in service.
- All pipes shall be colour banded and suitably labelled with the stream designation and direction of flow to enable individual lines to be identified throughout their run.
- Particular attention shall be paid to the layout of the chemical piping, which shall be arranged without clutter and shall be functional and neat in appearance. Generally, where piping is installed in ducts, it shall be supported not less than 150 mm clear of the floor.
- All piping routed under any type of structure or equipment shall be fully and completely encased in reinforced cement concrete, with the encasement thickness beyond the outer diameterofthe pipebeingatleast200 mmon allsides. Theencasement shallextend alongthe pipe length for a minimum horizontal distance of 1500 mm in each direction beyond the footprint of the overlying structure or equipment.
- All piping connecting to, entering, or exiting any and all structures shall be provided with appropriate restrained flexible connections and/or joints

at all such interfaces with structuresto allow for differential movement between pipe and structure in all directions without stressing or breaking the pipes.

- Appropriate restrained flexible connections and/or joints shall be provided for all pipes where they connect to any and all of the following:
    - Equipmentsuchaspumps,blowers,orinline devices

    - Valves
    - Wall,floor,orroofpenetrations
- Where piping or other materials susceptible to damage from ultraviolet radiation areemployed, they shall be protected fromsuch radiation through the use of appropriate additives and/or coatings and shall be physically shielded from direct sunlight at all times in theirnormal service location using enclosures, covers, canopies, roofs, and/or other similar means.
- Platforms, handrails/guardrails, ladders, and stairs shall be provided where necessary for proper, safe, and easy access to and/or operation of valves, gates, instruments, control panels, and other devices, equipment, or structures.
- The influent flow meter and influent sampling location shall be selected such that the true influent flow and characteristics will be measured without inclusion of in-plant recycles or other extraneous streams.
- Max. Velocity to be considered for sizing of channels at peak hourly flow is 1.2 m/s. Max. Velocityto be considered for sizingof gates at peakhourlyflow 0.96 m/s. Max. velocityto be considered for sizing of plant by-pass lines is 1.2 m/s.

ProcessandFacilities Description

This Process and Facilities description is intended to provide a general indication of the processes and types of facilities that the Contractor shall be required to design, construct, and operate, and apply to ISPS in this contract unless specifically indicated otherwise. The Contractor shall use this description together with other specific information for the ISPS provided elsewhere in these bid documents, including but not limited to Paragraph **Error! Reference source not found.** – "**Error! Reference source not found.**", Part 11 – "General and Particular Mechanical Requirements", and Volume 3 – "Drawings", all of which are integral to this Process and Facilities Description and are incorporated herein byreference.The Contractor mayproposealternateimplementation detailssuch as detailed site layouts and elevations of specific components. However, the Contractor shall strictly comply with the specified treatment concept, treatment unit processes, flow configuration (connectivity between unit processesandfacilities),performancerequirements(suchaseffluentandsludgequality andequipment efficiencies), and design criteria (such as design operating conditions, various process loading rates and/or detention times, volumes, and dimensions where specified).

Contractor should note that this particular contract may or may not include all of the components describedinthis"ProcessandFacilitiesDescription".Componentsincludedinthisspecificcontract are listed in Paragraph **Error! Reference source not found.**7 –

“**Error! Reference source not found.**”.

ISPS

TheISPSshallprovidesewagecollectionanddistribution,coarsescreening,andpumpingfunctions and capacities as follows:

- Receive into a common collection chamber/Inlet Manhole a combined total of 15/45 MLD design average/peak sewage flow from the 900 mm dia sewer.
- Provide 900 mm dia sewer from common collection chamber/Inlet Manhole to coarse screen inlet channel. If necessary intermediate manholes to be constructed.
- Provide downward opening overflow weir gate, distribution chamber, and piping for passive overflow of flows exceeding total design peak flow or emergency overflow to nearest receiving water body.
- Providenewcoarsescreeningdesignaverage/peakcapacityof15/45MLD.
- Provide an ISPS (including wet well, pumps, valve chamber, and other related equipment), with 15/45 MLD design average/peak capacity, for pumping to the 35 MLD Agaram STP.

ISPSInlet Manhole

For ISPS included in this contract, BWSSB shall be responsible for collecting and conveying sewage throughone or more underground sewer(s) to an inlet manhole and/or collection chamber located within the ISPS boundary, as specified in this contract document. The Contractor for this contract shall construct the inlet manhole and/or collection chamber and coordinate the exact location and elevation of such manhole and/or chamber with BWSSB. BWSSB will be responsible for the incoming pipe(s) to the manhole and/or chamber location. However, the Contractor shall be fully responsible for proper coordination to ensure proper alignments and interfaces and for proper implementation of all connections.

ISPSCoarseScreens

For the ISPS included in this contract that receives raw sewage directly from BWSSB sewer, incoming sewage shall be conveyed from the inlet manhole and chamber to the Coarse Screen influent channel via anappropriately sized gravity pipe or over appropriately sized downward opening overflow weir gate(s), and screened using Mechanical Raked Coarse Screens followed by J-type manual screen with Electric hoist forliftingplaced indeep concrete channelsimmediatelyupstreamoftheISPS wet well.Anelectronicallycontrolled automatic jam removal system for the Mechanical screen shall be provided in addition to the safety devices specified elsewhere in the document. The screenings removed by the screens shall be discharged at the appropriate elevation above ground on to a conveyor. A belt conveyor positioned above ground level shall convey the screenings through a SS316L chute to a screening collection Bins truck/tractor-trolley positioned at ground level. All Screens shall be provided with thimble mounted isolation motorised Sluice gates both on upstream and downstream. Motorised Sluice gates at Outlet of Effluent chamber. And also thimble mounted motorised Weir gates shall be provided in inlet chamber for overflow arrangement to

nearest Nalla above HFL. All the gates are operated by Portable trolley mounted Electrical actuator, and this actuator shall be design to operated all the gates.

ISPSWet Well

TheISPSsincludedinthiscontractshallbeofthewetwelltypewithNon-clogSubmersiblepumps.

Coarse-screened sewage from the Coarse Screens shall be collected via appropriately sized channels into a common channel which shall connect to the wet well.

Thewetwellshallbea two-compartmentCircularconcrete structure,dividedintotwoequal-sizedcompartments byafull-heightconcrete wall withanMotorised thimble mounted Sluice Gate atthebottom.Bothcompartments shall be identical and symmetrical, and shall be designed to be fully self-cleaning and prevent any accumulation of solids or debris under any and all flow conditions. Each compartment shall be provided with an adequate number of vents of adequate size to allow unrestricted changes in wet well liquid level. The vents shall belocated in open areas exposed to the atmosphere, and shall be terminated in “goosenecks” (inverted U fittings) minimum 200 mm dia. DI with screens to prevent entry of foreign objects into the vent piping. Wet well pump opening & valve chamber shall be covered with MS Grating & MS Chequered plates.

ISPS Pumps

The ISPS included in this contract, coarse-screened sewage shall be pumped bythe ISPS Pumps via one or more pumpingmain(s)asspecifiedinthiscontractdocument,tooneormoredestinationsasindicatedinParagraph 5.1–“IntermediateSewagePumpingStation(ISPS)”.IfthedestinationisanSTP,thepumpingmainshallconveythesewagetotheMediumScreenInfluent Channel of that STP. Pump speed and sequencing shall be automatically controlled based on wet well level.

Design/SizingCriteriaandOther Requirements

ISPS

Item/Parameter/Description	Units	IASOfficerslayout to Agaram STP
ISPSInletandOutletHydraulic Conditions		
IncomingSewerDetails		ProposedTrunkSewer
ExistingGroundLevelatISPS(EGL)	m	877.0
FinishedGroundLevelatISPS(FGL)	m	878.0
Nominaldiameter(s)ofincominggravitysewer(s)at ISPS – Contractor to field-verify DiameterofIncomingSewer	mm	900
MOC(s)ofincominggravitysewer(s)atISPS– Contractor to field-verify		RCC NP3

Item/Parameter/Description	Units	IASOfficerslayout to Agaram STP
Lowestincominggravitysewerinvertatinlet manhole of ISPS - Contractor to field-verify	m	870.5
Min dropfromlowest sewer pipe invertlevelto downstreamInletchambermaximumwaterlevel	m	0.3
FlowDetails		
AverageFlowrateforUltimateYear2055	MLD	15.00
	m^3/h	625
	m^3/s	0.174
PeakingFactor(PF)		3.0
	MLD	45.0
PeakFlowforUltimateYear2055	m^3/h	1875
	m^3/s	0.521
LeanFlowFactorforUltimateYear2055		0.50
LeanFlowforUltimateYear2055	MLD	7.5
	m^3/h	313
	m^3/s	0.087
AverageFlowrateforUltimateYear2055	MLD	15
PeakFlowrateforUltimateYear2055	MLD	45
LeanFlowrateforUltimateYear 2055	MLD	7.5
InletManhole		
Fordepthsabove2.30mandupto9.0m,minimum manhole diameter shall be	m	1.5
MinClearancetobeprovidedoneachsideto accommodate pipe in the manhole	mm	150
MinDiameterofManhole(Consideringincoming Sewers 900 mm)	m	2.0
OverflowChamber		
Widthofthe Chamber	m	2.0
LengthoftheChamber	m	2.5

Item/Parameter/Description	Units	IASOfficerslayout to Agaram STP
Depthofthe Chamber	m	As per the site conditionleadoffle vel with respect to HFL
ISPSCoarseScreenInletChamber		
MinNoofUnits		1
Type		Rectangular
MOC		RCC
Peakchannelvelocityatpeakflow	m/s	0.75
MaxSWDatpeak flow	m	0.75
MinFreeboard	m	0.75
Min length	m	2.5
Min Width	m	3.2
ISPSCoarseScreen Channels		
Screentype		J-typewithchannel guide (C-type) arrangement with lifting beam with Electric Hoist
TotalUnits	Nos.	2
MinNoofUnits-Working	Nos.	1
MinNoofUnits-Standby	No.	1
MOC-Channel		RCC
MOC-Screens		SS316L
Angleofinclinationofscreen	deg.	90
MaxSWDatpeak flow	m	0.7
Velocitythroughopeningsatpeakflow(maximum)	m/sec	1.2
Clearspacingbetweenbars	mm	100
MinBardimension(mm)	mm	12mmx50mm (Width/depth)
Maxwidthperchannel	m	1.4

Item/Parameter/Description	Units	IASOfficerslayout to Agaram STP
MinFreeboard	m	0.50
LiftingArrangement		2.0TonElectrichoist with Rope
Screentype		Multirake Rake Bar screenwithMechanical Cleaning Auto Jam Removal system
TotalUnits	Nos.	2
MinNoofUnits-Working	Nos.	1
MinNoofUnits-Standby	No.	1
MOC-Channel		RCC
MOC-Screens		SS316L
Angleofinclinationofscreen	deg.	75
MaxSWDatpeak flow	m	1.4
Velocitythroughopeningsatpeakflow(maximum)	m/sec	1.20
Clearspacingbetweenbars	mm	50
MinBardimension(mm)	mm	12 mm x 6 mm x 50 mm(front/back/depth)
Maxwidthperchannel	m	1.4
MinFreeboard	m	0.50
MaximumHeadlossacrossthescreen	m	0.3
MinimumLengthofApproachChannelUpstreamof Screen	m	3.5
MinimumLengthofApproachChannelDownstream of Screen	m	2.5
MinimumHorizontallengthcoveredbyScreeninthe Channel	m	2.4
ISPSCoarseScreenEffluentChannel		
MinNoofUnits		1
MOC-Channel		RCC

Item/Parameter/Description	Units	IASOfficerslayout to Agaram STP
Peakchannelvelocityatpeakflow	m/s	0.75
MaxSWDatpeak flow	m	0.7
Minfreeboard	m	0.50
Minlength	m	2.0
Min Width	m	3.2
InletBafflewallarrangementuptoLWLinWet well	m	Square
No.ofBafflewallarrangement	Nos.	1 (one)
ISPSWet Well		
AverageFlow	m^3/s	0.174
PeakFlow	m^3/s	0.521
Lean Flow	m^3/s	0.087
Noofstructures		1
Type		CircularWetPitwith Submersible pumps
Noofwetpit compartments		2
MOC-Structure		RCC
MinHRTatpeak flow	min	5
Minwetwelloperatingvolume	cum	158
Operatingvolumedepth-minimum	m	2.0
FreeboardaboveHighHighWaterLevel	m	0.3
Differenceb/ wHighHighwaterLeveltoHighwater Level	m	0.3
Differenceb/ wLowLowwaterLeveltoLowwater Level	m	0.3

Item/Parameter/Description	Units	IASOfficerslayout to Agaram STP
Minpumpsubmergence	m	2.0
MaxHRTatdesignavgflow	min.	30
ISPS Pumps		
Pumptype		Non-clogSubmersible pumpswithGuidepipe & Chain arrangement
NoofpumpstobeInstalled		4(Min1Nos.onVFD)
Noofpumps-Working		2
Noofpumps-Standby		2
Designcapacityperpump	cum/hr	938
Minimumdeliveryhead	m	20
MaxvelocityforIndividualdeliveryline,allpumping main	m/s	2.0
Hazen-William'scoefficient		130
Minpumpefficiencywithinflow-headoperating envelope		78%
Minmotorefficiency		90%
MinVFDefficiency		-
ISPSPumpingMainChamber(Motorised KGV)		
Min length	m	2.5
Minwidth	m	2.5
Mindepth	m	3.0
ISPSPumpingMainChamber(Non-Return Valve)		
Min length	m	3.0
Minwidth	m	3.0
Mindepth	m	3.0

Item/Parameter/Description	Units	IASOfficerslayout to Agaram STP
ISPSPumpingMainChamber(ElectroMagnetic Flow meter)		
Min length	m	2.5
Minwidth	m	2.5
Mindepth	m	3.0
TransformerYardforISPS		
Minnoof units		1
MOC-Boundary		ChainLinkFencing withgate
MOC-Firewall		Min.230mmRCC or Min. 355 mm Brick
TransformerYard		
Min length	m	10
Minwidth	m	6
DGShedforISPS		
Minnoof units		1
MOC-Roof,columns,beams		RCC
Overall dimensions		
Min length	m	6.5
Minwidth	m	3.0
Minheight	m	6.0
ElectricalPanelRoomforISPSaboveWetwell &		
Minnoof units		1
MOC-Roof,columns,beams		RCC
MOC-Sidewalls		200mmsolid concrete blocks
Overall dimensions		
Min length	m	10.5
Minwidth	m	10.5
Minheight	m	5.5
Metering&HTYardforISPS		
Minnoof units		1
MOC-Roof,columns,beams		ChainLinkFencing with Gate

Item/Parameter/Description	Units	IASOfficerslayoutto Agaram STP
MOC-Sidewalls&partitionwallforHTandPCC panels		-
Overall dimensions		
Min length	m	8
Minwidth	m	4.5
Minheight	m	-
ControlRoom(forSCADA/HMIsystem)	m	3.8x3x4.5
Minnoof units		1
MOC-Roof,columns,beams		RCC
MOC-Side walls&partitionwall		200mmsolidconcrete blocks
Overall dimensions		
Min length	m	3.8
Minwidth	m	3
Minheight	m	4.5
DewateringPumpsforWet well		
No.ofPumps	Nos.	2
Minnoofunits -Working	Nos.	1
Minnoofunits -Standby	Nos.	1
Typeof Pump		Non-clogSubmersible pumpswithGuidepipe & Chain arrangement
Pumpcapacity	Cum/hr	20
EmergencyDrainage/ DewateringPumpfor Manhole/Chamber/Screen channel		
No.ofPumps	Nos.	2
Minnoofunits -Working	Nos.	1
Minnoofunits -Standby	Nos.	1

Item/Parameter/Description	Units	IASOfficerslayout to Agaram STP
Typeof Pump		Non-clogSubmersible pumps Chain arrangementand Hose Piping up to 50 m
Pumpcapacity	Cum/hr	50

Note:

1. Part–5(ProcessRequirement)willbeprevailingoverPart-11(General&Particular Mechanical Requirement) for process related requirement.
2. Part–11(General&ParticularMechanicalRequirement)willbeprevailovertheGeneral Mechanical Specification.

EndofPart5

PART6

GENERALELECTRICALREQUIREMENTS

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PART6

GENERALELECTRICALREQUIREMENTS

Introduction

The general requirements include design, manufacture, inspection and testing at works, supply and deliveryatsite,unloadingandstoringtheequipmentat siteofinstallation,testingandcommissioning of the equipment at site listed below. All the electrical and instrumentation equipment to be supplied under this contract have to be of reputed makes. The equipment of those manufacturers, who have sufficient proven experience of manufacturing the respective equipment of similar capacity, shall be considered. The respective equipment should have been manufactured, supplied, installed, commissioned successfully and should be running satisfactorily since at least last 5 years continuously. Certificatesfromthe end users, regardingtheirsatisfactoryPerformances, shallhave to be submitted in this regard. All equipment shall be OEM (Original Equipment manufacturer) type only.

Particularrequirementsofallelectricalequipmentarecoveredunder‘Part12:Particul arRequirements – Electrical’ of this Specification. All the equipment / items shall conform to latest applicable standards specified. In case of Conflict between standards and this specification, this specificationshall govern.

Equipment

(a) Transformers
(b) MVMetalenclosedswitchboards&switchgears
(c) 415VMetalenclosedswitchgearsPCC/MCC/DGPCCPanel
(d) Powercapacitorandcontrolpanel(APFC)
(e) SoftStarters
(f) DieselStandbyGeneratorwithAMFControlPanelandSynchronizingpanel
(g) Battery,BatteryChargerandDCDistributionBoard
(h) VariableFrequencyDrives
(i) Non-SegregatedBus Duct
(j) Power&Controlcables
(k) CableCarriersystem
(l) Lightingsystem
(m) EarthingandLightningprotectionsystems

Transformers

Transformersystemshallhaveprovisionofinter-operabilitywithinstrumentationcontrolssystem.

Applicable Standards

The design, manufacture, testing and performance of equipment shall comply with all currently applicable standards, codes of practice, regulations and safety codes in the locality where the equipment will be supplied. Nothing in this specification shall be construed to relieve the VENDOR/BIDDER of his responsibility. In case of conflict between these standards and this specification, more stringent of the two requirements shall govern.

The codes and standards mentioned in the various specifications and requirements specified in the bid document shall be latest as on the day of award of contract of theworks unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Employer in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Employer may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirementsoftheprojectordoesnotimpactsafetypractices.Anycostimpa ctarisingout of such revisions shall be mutually agreed

Someofthecurrentlyapplicablestandardsareindicated below

PowerTransformer	IS:2026/IEC:60076
FittingsandAccessories	IS:3639
OutdoortypeOilimmerseddistributiontransformersupt o	IS:1180LatestAmend.4

2500kVA,33kVTransformer Procedurefor testing	 IS:1180/IS:2026
LoadingGuideofoilimmersedtransformer LoadingGuideforDry-typePowerTransformers	IS:2026-7,IEC:60076-7 IS:2026-12,IEC:60076-12
TransformerOil	IS:335/BS 148/IEC:60296
Bushings	IS/IEC:60137,IEC60137
Degreeof Protection	IS/IEC60529,IEC60529
DoublefloattypeBuchholz Relay	IS:3637
Electricalinsulationclassifiedbythermalstability	IS 1271/BS:2757/IEC:60085
CodeofPracticeforselection,installation,andMaintenanceof transformers	IS:10028
ManualonTransformers	CBIPPublicationNo.317

FeaturesofConstruction

Thetransformertankshallbemadefromhigh-gradesheetsteel,suitablyreinforcedbystiffenersmade of structural steel sections.All seams, flanges, lifting lugs, braces, and other parts attached to the tank shall be welded. The interior of the tank shall be cleaned by sand blasting and painted with two coats of heat resistant, oil insoluble paint. Adequately sized manholes shall be provided for ease of inspectionandmaintenance.Steelboltsandnutsexposedtoatmosphere,shallbegalvanized.Thetank cover shall be removable and shall be suitably sloped so that it does not retain rainwater.

Liftinglugsandeyeboltsshallbesolocatedthat asafeclearanceshall beobtainedwithout theuseofa spreader, between the sling and transformer bushings.

Transformersshallbeprovidedwithfixedtyperadiators.Finsoftheradiatorsshallnothavesharp edges and shall be rounded in shape.

The transformer core shall be constructed from high grade, non-ageing, cold-rolled, grain oriented, siliconsteellaminations.Thesteellaminationsshallbeof"core"type.Eachlaminationshallbecoated with insulation which shall be unaffected by the temperature attained by the transformer during service. Core laminations shall be annealed, and burrs removed after cutting. Cut edges shall be insulated. The framework and clampingarrangements of core and coil shall be securelyearthed inside the tank by a copper strap connection to the tank.

WindingsshallbeofelectrolyticCopperof99.99%purity.

Windings and insulation shall be so arranged that free circulation of oil shall

be possible between coils,betweenwindings,andbetweenwindingandcore.Thewindingsshallbefullyshrunkunder

vacuumbeforeassembly.Highvoltageend-windingsshallbesuitablybracedtowithstandshortcircuit stresses and stresses caused up by surges.

ThesequenceandorientationofHV/ LVsidephaseandneutralbushingsshallbeasspecifiedinthe latest edition of relevant IS.

TransformershalloperatewithoutinjuriousheatingattheratedkVAandatanyvoltageupto+10% of the rated voltage of any tap. Transformer shall be designed for 110% continuous over-fluxing withstanding capability.

TransformershallbeprovidedwithZerosequence/ earthfaultcurrentprotectiononLVside transformer feeder protection. (Neutral CT to be provided in case of solid grounding)

WindingConnections

WindingsshallbeofHV:Delta&LV:Star,vectorgroup Dyn11.

Rating

TheratingoftransformersshallbeasperstandardratingsshowninIS1180/ CBIPPublication317. The energy efficiency level (EEL) of the transformer shall comply with the latest amendment of IS 1180 with minimum EEL of Level II.

Typeofcooling

Thetransformersshallbeoilimmersedwithnaturaloilcirculation,typeONAN.

Impedanceand losses

Thepercentageimpedance,noload&loadlossesshallbeasperIS1180latestamendment.

Oil

Transformersshallbesuppliedcompletewithtransformeroil, itshallbe‘’PCBfreeandpolycyclic Aromatic Hydrocarbons free mineral oil’’ OR Synthetic ester Oil

Performancerequirements

(a) The transformers shall be suitable for operation without danger on to any particular tapping at the rated kVA provided that the voltage does not vary by more than ± 10% of the voltage corresponding to the tapping.

(b) The transformers shall be suitable for continuous operation with a frequency variation of ± 5% of rated frequency, combined voltage and frequency variation should not exceed 10%.

(c) All transformers shall be capable of withstanding external short circuit without damage as perIS 2026.

(d) The transformers shall be capable of continuous operation in accordance with relevant IS for loading of oil immersed transformers.

(e) The neutral terminal of star windings shall be designed for the highest over current that can flow through this terminal.

(f) The temperature rise of oil & windings over the specified ambient temperature shall not exceed the limits given below with air as cooling medium when tested in accordance with IS 2026(Part-2).

Topoil(measuredbythermometer)	:	35°C
Winding(measuredbyresistance)	:	40°C

(g) Noise level of transformers measured at a distance of 1 metre shall be as per limits specified in NEMA standard/IS 2026-10.

Tap Changer

For transformer of rating less than or equal to 500kVA, tap changing shall be carried out by means of an off circuit externally operated self-positioning switch when the transformer is in de-energized condition. Tapings shall be provided on the higher voltage winding for variation of HV voltage from plus 5% to minus 10% in steps of 2.5%. For transformer of rating greater than 500kVA on load tap changershallbeprovidedonHVsideforvariationHVvoltagefromplus5%tominus15%in stepsof 2.5% with Remote Tap Changing Controller (RTCC), Automatic Voltage Regulator (AVR) etc.

OnLoadTap ChangingGearforTransformer (above 500kVA)

(a) The OLTC gear shall be designed to complete successfully tap changes for the maximumcurrent to which transformer can be loaded i.e., 150% of the rated current. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault currents withoutinjury.

(b) Whenatapchangehasbeencommenceditshallbecompletedindependentlyofthe operationof the control relays and switches. Necessary safeguard shall be provided to allow for failure of auxiliarypower supplyor anyother contingencywhich mayresult inthe tap changer movement not being completed once it shall be commenced.

(c) Oil in compartments which contain the making and breaking contacts of the OLTC shall notmix with oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator. A Buchholz relay shall be installed inthe above pipe. The segregated compartment (conservator) shall be provided with a prismaticoil level gauge.

(d) Oil, in compartments of OLTC which do not contain the make and break contacts, shall be maintained under conservator head by valve pipe connections. Any gas leaving these compartments shall pass through the Buchholz relay before entering the conservator.

(e) Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasketed and bolted cover with liftinghandle.

(f) OLTC driving mechanism and its associated control equipment (Local) shall be mounted in an outdoor, weather-proof cabinet with IP65 protection which shall include:

(i) Drivingmotor(415V,3-phase,50Hz.ACsquirrelcage).
(ii) MotorstartingcontactorwiththermaloverloadrelaysisolatingswitchandMCB.
(iii) Duplicate sources of power supply with automatic changeover from the running source to the standby source and vice versa.
(iv) Controlswitch:Raise/Off/Lower(springreturntonormal type).
(v) Remote/Off/Localselectorswitch(maintainedcontact type).
(vi) Mechanical tap position indicator showing rated tap voltage against each position andresettable maximum and minimum indicators.
(vii) Limitswitchestopreventmotorover-travelineitherdirectionorfinalmechanicalstops.
(viii) Brakeorclutchestopermitonlyonetapchangeatatimeon manualoperation.
(ix) Emergencymanualoperatingdevice(handcrankorhand wheel).
(x) Afive-digitoperationcounter.
(xi) Electricallyinterlockedreversingcontactors(preferablyalsomechanicallyinterlocked).
(xii) 240V,50Hz.ACspaceheaterwiththermostatandMCB.
(xiii) InteriorlightingfixturewithlampdoorswitchandMCB.
(xiv) Gasketedandhingeddoorwithlockingarrangement.
(xv) Terminalblocks,internalwiring,earthingterminalsandcableglandsforpowerand control cables.
(xvi) Necessarydigitalprotectionrelays,contactors,currenttransformersetc.

(g) ControlRequirementsforOLTC
Thefollowingelectricalcontrolfeaturesshallbeprovided:

(i) Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in

case of failure of external power supply.

(ii) Onlyonetapschangefromeachtapchangeimpulseevenifthecontrol switchesorpush button shall be maintained in the operated position.

(iii) Cut-off of electrical control when manual control shall be resorted to. Cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.

(iv) Cut-offofelectricalcontrolwhenittendstooperatethetapbeyonditsextreme position.

(h) AutomaticControlof OLTC

AutomaticOLTCcontrolshallincludethefollowingitems:

(i) Voltagesettingdevice

(ii) Voltagesensingandvoltageregulatingdevices.

(iii) LinedropcompensatorwithadjustableRandXelements.

(iv) Timer 5-25 seconds for delaying the operation of the tap changer in the first step forevery tap change operation.

(v) Adjustabledeadbandforvoltagevariation

(h) <u>OLTCPanel:</u>

TheOLTCremote controlequipment shall be suitablefor 110V DC supplyand shallbe housed inanindoorsheetsteelcubicletobelocatedinaremote-controlroom.TheOLTCcontrolpanel shall comprise of rigid welded structural frames made of structural steel section or of pressed and formed cold rolled steel and frame enclosures, doors and partitions shall be of cold rolled steel of thickness 2mm. Stiffeners shall be provided wherever necessary. All doors, removable covers and plate shall be gasketed all around with neoprene gaskets. Panel shall be dust, weather and vermin proof providing degree of protection of IP54, colour of finish shade for interior and exterior shall be glassy white and light grey semi glossy shade 631 of IS-5 respectively. Earthing bus shall be of 25 x 6 mm copper.

TheOLTCremotecontrolequipmentshallcompriseofthe following:

(i) Controlswitch:Raise/Off/ Lower (Springreturntonormaltype)

(ii) Auto/Off/Manualselectorswitch(Maintainedcontact type)

(iii) Tappositionindicator.

(iv) Fasciatypealarmannunciationswith“accept”and“lamptest”facilities.

- A.C.supplyfailure.
- Drivemotorautotripped.
- Tapchange delayed.

(v) Necessaryauxiliaryrelays.

(vi) Lampindicationsfor:

- Tapchangeinprogress.
- Lowerlimitreached.
- Upperlimit reached.

(vii) DoublecompressionCableglandsforpowerandcontrolcables.

(viii) 240VratedpanelspaceheaterwiththermostatandON-OFFMCB.

(ix) LED type Energy efficient (lumen per Watt shall be specified)

interior lighting fixture with lamp and door switch.

(x) MCB/ HRC fuses.
(xi) Terminalblocks.
(xii) Internal wiring.
(xiii) Earthingterminal.

OffLoadTap ChangingMechanismforTransformer(Less than orequal to 500kVA)

Offcircuittapchangingmechanismshallcomprisethefollowing:

- Operatinghandleofwheel,accessiblefromground level.
- Tappositionindicator.
- Padlockingarrangement.
- The tap-changer connections and contacts shall be accessible through an access hole havinga bolted gasketed cover.

MarshallingBox

Marshallingboxshallbeprovidedtomarshaltemperatureindicatorswithauxiliarycontacts,Buchholz relay and bushing CT shall marshal to the contacts/terminals of electrical devices mounted on the transformer

- Theinterconnectioncablingbetweenthemarshallingboxandtheaccessorydevicesbyeither PVC insulated FR wires in GI conduits or PVC insulated inner extruded PVC, Outer sheath PVC FR armoured cable and

- Necessary compression type, brass cable glands (at easily accessible location) at the marshalling box for the above-mentioned cables.

The marshalling box shall be tank mounted, outdoor type, IP55 protected, weather-proof, sheet-steel(2 mm thick) enclosed, with hinged door having padlocking facility. Colour finish shall be epoxy paint,powdercoatedwithminimumthicknessof50micronsanddarkgreyshadeRAL632.Alldoors, covers and plates shall be fitted with neoprene gaskets. Bottom shall be at least 600 mm from floor level and provided with gland plate and cable glands as required. Top surface shall be sloped.

All contacts for alarm, tripand indicationcircuits shall each be potential free, wired for auxiliaryD.C. supplyasspecifiedand broughtouttoseparateterminalsattheterminalblocksinthemarshalling-box. Terminals shall be rated for 10A.

Wiringshall be FRLS/HFFR with multistranded, copper conductors of sizes not smaller than 1.5 sq.mmforcontrol and2.5sq.mmforCT circuits.CTterminalsshallbeprovidedwithshorting& earthing facility.

ThemarshallingboxshallbeprovidedwithglasswindowsoastomaketheWTIandtheOTIdials visible from the outside without opening the door.

The marshalling box shall house the winding temperature indicator (WTI, 150 mm dial 240-degree scale), the oil temperature indicator (OTI, 150 mm dial 240-degree scale), terminal block, 60W anti- condensationheater, 5/15Aindustrial typefive pin socket and a LEDfixture, suitablefor operatingon 230VAC.ContactsofBuchholzrelay,WTI,OTI, magneticlevelgauge,PRD,OSRshallbewiredup to the terminal block.

FittingsandAccessories

Thefollowingfittingsandaccessoriesshallbeprovidedwithtransformer:

(a) Nameplate,ratingplateanddiagramplateasperIS1180.

(b) Twoearthingterminalsonoppositeendsofthetransformertank.

(c) Neutral earthing bar of copper of specified section installed from the neutral bushing to ground level suitably supported along its run-on porcelain insulators, together with clamping arrangements at neutral bushing and for two Employer's earth conductors. The supporting insulators shall be tank mounted.

(d) Inspectionmanhole(s)withcover(s)onthetopcoverofthe transformer.

(e) Lifting lugs or eyes for lifting of fully assembled transformer, core assembly and tank core by crane.

(f) Conservator, complete with filling plug, sump and drain valve, and a shut-off valve on the pipe connection between transformer tank and conservator, to permit removal of the conservator.The conservator shall be designed to maintain an oil seal through a temperature range of 100 Deg C.

(g) Oillevelgaugeindicatingoillevelatminimum,300Candmaximumoperatingtemperature.

(h) Weather-proof dehydrating breather with clear polycarbonate desiccant container weight of the desiccant shall meet 400 charge life days. Desiccanttype shall beself-indicatingbread silica gel as the dehydrating agent.

(i) For all transformers, magnetic type oil level gauge with low oil level alarmcontact, mounted on the conservators with waterproof and dustproof terminal box and shall be wired to marshalling box.

(j) Gas detector relays with separate alarm and trip contacts complete with shut-off valves shall be wired to marshalling box.

(k) Separate drain valve, oil sampling valve with plug and top filter valve shall be provided on the tank and shall be leak proof after commissioning.

(l) Explosion vent with diaphragm for relieving pressure inside the transformer. The device shallbe rain proof after operation. For transformers of 500kVA and above an equalizer pipe connecting the pressure relief device to the conservator shall be supplied.

(m) Buchholz relay, pressure relief device and winding and oil temperature protection with alarm and trip contacts shall be provided on all transformers of ratings 1000 kVA and above.

(n) Separately mounted, waterproof, and dustproof marshalling box housing the Buchholz relay wiring, oil level low wiring, oil temperature indicator and winding temperature indicator with alarm and trip contacts and marshalling facilities for electrical devices mounted on transformer including load management signal shall be provided to give an information about the over loading condition of the transformer and all signals shall be wire able to alarm annunciation. (The signal shall not give indication for momentary over loading). The marshalling box shall be in accordance with IS 13947-1. The degree of protection shall be IP65 with space heaters etc.

(o) For transformers rated 500KVA and above. Adequate number of air vents for relieving trapped air during oil filling / during maintenance and shall be leak proof after commissioning.

(p) Thermometer pockets and sensing element mounted on the transformer tank cover formeasuring top oil temperature.

(q) Fourjackingpadsforliftingthetransformerwithjacks.

(r) Pullingeyesandskidsforthemovementofthetransformer.

(s) Bidirectionalwheelsformovementofthetransformer.

(t) Aladderassemblyshallbeprovidedtoreachthetopofthetransformerformainten ancework. It shall be possible to padlock the ladderto thetransformer tankso that ladder cannot be removed. Usage of transformer structure / marshalling boxes etc. as means to climb transformer are not acceptable.

(u) Accessoriesforclampingthe wheelmountedtransformer tothefoundationinorder towithstand earthquake forces with a seismic acceleration of 0.2g.

(v) Transformer shall be supplied complete with insulating oil required for first

filling plus 10% excess oil in non-returnable drums (With gas analysis report).

CableTerminations/CablingRequirement

Cable termination boxes for transformers shall be suitable for dry termination of HV and LV cables. Non-magneticglandplatesshallbeprovidedfortheterminationofcables.Maximumsizeofthecable and number of cables that can be terminated shall be indicated.

Itshallbepossibletoremovethecableboxeswithoutdismantlingthecableglandingor drainingthe oil. Disconnecting links shall be provided to facilitate testing of the cable.

Alltransformersshallbeprovidedwithalarmannunciationonbreakercontrolpanel.

ToleranceonLosses

ThepermissibletolerancesontheguaranteedvaluesoftransformerlossesshallbeasperIS2026.The values of load- losses and No-load losses shall be within the values given in latest edition of CBIP.

Lossesat50%load&100%loadshallbeminimumEnergyEfficiencyLevel(EEL) - 2asperlatest amendment of IS 1180.

Costloadingshallbedoneforcapitalizationoflossesattimeofbidevaluationforalltransformersas per CBIP Manual on transformers.

Rejection

The Employer or Employer’s Representative reserves the right to reject the transformer if the same does not meet the specification requirement, subject to tolerances as per IS 2026. The impedance valuesdifferenceandtemperaturerisevalues shall notexceedfromtheguaranteedspecifiedvalues. Therejectedtransformersshallbereplacedbytransformerscomplyingwiththerequirementsofthis specification at the Contractor’s cost.

If the commissioning of the project shall be likely to be delayed by the rejection of a transformer, the Employer’s Representative reserves the right to accept the rejected transformer until the replacement transformershallbemadeavailable.Transportingtherejectedandreplacementtransformersaswellas installation and commissioning of both the transformers shall be at the Contractor's cost.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc shall be

submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

QualityAssurancePlan (QAP)

QAP shall list and define in sequential order all process control activities, inspection and tests proposedtobeperformedontheequipment/materialstartingfromcomponentprocurementandfrom testing stages to product dispatch. The QAP shall indicate and identify the applicable standards, detailed description with diagramthe procedure, acceptance criteria,extentof checkand recordto be generated.

MVMetalEnclosedSwitchboards&Switchgears

MVMetalenclosedSwitchboardsandSwitchgearsystemshallhaveprovisionsuchthat inter- operability with instrumentation control system.

Applicable Standards

Theswitchgearanditscomponentsshallconformtothelatestapplicablestandardsspecifiedbelow:

The design, manufacture, testing and performance of equipment shall comply with all currently applicable standards, codes of practice, regulations and safety codes in the locality where the equipment will be supplied. Nothing in this specification shall be construed to relieve the VENDOR/BIDDER of his responsibility. In case of conflict between these standards and this specification, more stringent of the two requirements shall govern.

The codes and standards mentioned in the various specifications and requirements specified in the bid document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Employerin caseofanyrevisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Employer may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed

Someofthecurrentlyapplicablestandardsareindicated below

SwitchgearGeneralRequirements	IS/ IEC:60947,BSEN:60947, IS/IEC:61439-1
ACCircuitBreakers	IS/IEC62271-100

FactoryBuiltAssembliesofSwitchgearandControl GearForVoltagesUptoandincluding1000VACand 1500 V DC	IS:8623,BSEN:61439-1,IS/IEC 61439-1 IEC62271-200

CurrentTransformers	IS:16227/BS:7626/IEC61869-2
VoltageTransformers	IS:16227/BS:7625/IEC:60869-3
ArrangementforSwitchgearBusbars,MainConnections and Auxiliary wiring	IS:5578,11353,BS:159
BusbarSupportinsulators	IS:2544/BS:3297/IEC:60273
Degreeof Protection	IS/IEC:60529,IEC:60529
ElectricalRelaysforPowersystemprotection	IS/IEC:60255
ElectricalIndicatingInstruments	IS:1248/BS: 89/IEC: 60051
HighVoltage Fuses	IS:9385/BS:2692/IEC:60282
ACElectricityMeters	IS:722, 8530/BS:5685/IEC: 60145, 60211
Specificationforcopperrodsandbarsforelectrical purposes	IS:613
Codeofpracticeforphosphatecoatedironandsteel	IS:6005/BS: 3189
AlternatingcurrentSwitchesforvoltagesabove 1000V	IS:9920/ IEC:60129, 60265
HRCCartridge fuses MiniatureCircuitBreakers	IS:13703-2/ BS1362/IEC 60269 IS/IEC:60898
Toggleswitches	IS:3452/BS: 3676
Codeofpracticeforselection,installationand maintenance of switchgear and control gear	IS: 10118
AirBreakswitches	IS/IEC60947-3,BSEN60947-3/ IEC:60947-3
ClassificationofHazardousareashavingFlammable gases and vapors for Electrical Installation	IS5572,IEC60079-10
Electricalapparatusforexplosivegasatmospheres- General Requirements Faultlevelcalculation Testing Guide	IEC60079 IS: 13234 / IS:2026 ANSI/IEEEC.37.2 0.7

ConstructionalFeatures

Switchgeardesignshallbeofmetalenclosed,singlefront,freestanding,floormountedandfully compartmental execution having separate sections for each circuit

(a) control,meteringandrelayingdevices

(b) circuitbreaker/disconnectingswitch

(c)busbars

(d) voltagetransformersand

(e) powercableterminations&currenttransformers

Each Circuit shall have a separate vertical panel with distinct compartments for main bus bars, circuit breaker,cableterminationandauxiliarydevices.Theadjacentpanelsshallbecompletelyseparatedby steel sheets except in bus bar sheet compartments where insulated barriers shall be provided to segregate adjacent panels. Compartments with doors for access to operating mechanism shall be so arrangedasnottoexposehighvoltagecircuits.Switchgearcubicleshallbeprovidedwithhingeddoor on the front with facility for locking door handle. Stiffeners shall be provided wherever necessary to strengthen the door and side covers. Switchboard shall be dust and vermin-proof and shall have a degree of protection of enclosure of IP 4X and the relay and meter compartments shall have a degree of Protection not less than IP 52. All removable covers shall be gasketed all around with neoprene or superior gaskets.

Instruments, relays and control devices shall be flush mounted on hinged door of the metering compartment located in the front portion of cubicle. The metering compartment shall be properly shielded to prevent maloperation of electronic equipment such as numerical / static relays due to electro-magneticfields.Alltransformersshallbeprovidedwithalarmannunciationonbreaker control panel.

Separateremovableglandplatesshallbeprovidedforpowerandcontrolcables.Theglandplatefor the power cables shall be of non-magnetic material for single core cables

Each switchgear cubicle shall be fitted with a label on the front and rear of the cubicle. Each switchboardshallalsobefittedwithlabelindicatingtheswitchboarddesignation,ratingandduty. Each relay, instrument, switch, fuse and other devices shall be provided with separate label.

Thefullydraw-outmodulesshallhaveallthecircuitcomponentsmountedonwithdrawabletypesteel chassis. All power and control connections shall be of the draw out type. It shall be possible to withdraw the chassis mounted circuit components without disconnecting any connections. All draw out contacts shall be of silver-plated copper.

In case of circuit breaker compartments, suitable barriers shall be provided between breaker and all control, protective and indication circuit equipment including instrument transformers such that no live partsare accessible. Externalcable connectionsshallbethrough separate cable compartmentsfor powerandcontrolcables.Safetyshuttersshallbeprovidedtocoverupthefixedhighvoltagecontacts on busbars when the circuit breaker carriage shall be moved to ‘test’ and ‘isolated’ positions.

Onemetalsheetshallbeprovidedbetweentwoadjacentverticalsectionsrunningtoth efullheightof the switchboard except for the horizontal busbar compartment. However, each shippingsection shall have metal sheets at both ends. After isolation of the power and control connections of a circuit, it shall be possible to carry out maintenance in a compartment safely, with the busbars and adjacent circuits alive.

All sheet steel work shall be phosphate coated in accordance with the following procedure and in accordancewithIS:6005“CodeofPracticeforPhosphatecoatedIronandSteel”.Oil,gr ease,dirtand swarfshallbethoroughlyremovedbyemulsioncleaning.Rust andscaleshall beremovedbypickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

Afterphosphatecoated,thoroughrinsingshallbecleanwaterfollowedbyfinalrinsingw ithdilute dichromate solution and even drying.

The phosphate coating shall be followed by the application of two coats of ready mixed stoving type zincchromateprimer.Thefirstcoatmaybe“flashdried”whilethesecondcoatshallbest oved.After application of the two coats of primer finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests.

Thefinal finishedthicknessofpaintfilmonsteelshallnot belessthan80micronsandshall not be more than 120 microns. Finished painted surface of panels shall present an aesthetically pleasing appearance free from dents and uneven surface.

Asmallquantityoffinishingpaintshallbesuppliedforminortouchinguprequiredatsit eafterthe installation of the panels.

Circuit Breaker

Circuit breakers shall be vacuum type (VCB) with three separate single pole interrupting units, operated through a common shaft bya sturdyoperating mechanism. Surge Arrestors shall be provided foreachmotor/transformerfeeder.CircuitBreakersshallbere-strikefree,storedenergyoperatedand trip free type. Circuit breaker along with its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow easy movement. Plugs and sockets for power circuits shall be silver faced and shall be insulated withsuitable insulating material shrouds. All correspondingcomponents of circuit breaker cubicles of same ratingshall be interchangeable with one another. Anti-pumping relay and trip coil suspension relay shall be provided.

All VCB trucks of same rating shall be interchangeable. Closing coil shall be operable with control supplyvoltagevariationintherangeof 85-110%andtrippingcoil shall beoperableintherangeof 70- 110%.

There shall be ‘Service’, ‘Test’ ‘Fully withdrawn’ positions for the breakers. In the ‘Test’ position the circuitbreakershallbecapableofbeingtestedforoperationwithoutenergizingthepowercircuits,i.e., the control circuits shall remain undisturbed while the power contacts shall remain disconnected.
Separatelimitswitches,eachhavingaminimumof2‘NO’+2‘NC’contacts,shallbeprovidedfor

both ‘Service’ and ‘Test’ positions of the circuit breakers. All these services, test, fully withdrawn, springchargeandalsobreakerON/OFFshallbevisiblemechanicallyfromoutsidetheb reakerpanel when the front door is closed.

Electrical closing & tripping shall be performed by shunt trip & close coils both in Local, Off & Remote mode, selector switch lockable in “Local” position shall be provided on the cubicle door. ‘Red’and‘Green’indicatinglampsshallbeprovidedoncubicledoortoindicatebreaker closeand open positions. Breaker “Service”, “Test” and “breaker readiness” positions shall be indicated by separate indicating lamps on the cubicle door.

Connectionofthecontrol/ interlockingcircuitsbetweenthefixedportionofthecubicleandthe breaker carriage shall be preferably by means of plug socket arrangement.

10%sparefeederswithatleastoneforeachtypeofhighestratingshallbeprovidedin each switchgear.

Surgearrestorsshallbeprovidedforallincomer andtransformerfeeders,whichshallbemetaloxide gapped or gapless, type generally in accordance with IEC 60099-1 and suitable for indoor only.

Main Busbar

Busbars shall be fully insulated with flame retardant heat shrinkable sleeves with removable shrouds for protecting all joints. The busbar phases shall be clearly identified with suitable colour coding at bothendofeachtransportunit.Thewithstandtemperatureofsleevesshallbeatleast5d egcentigrade more than maximum busbar temperature. The busbar temperatures shall be limited to the values indicated in the data sheet-A1 without forced cooling.

Busbarsshallbesupportedoninsulatorscapableofwithstandingdynamicstressesduetosh ortcircuit

OperatingMechanism Control

- Circuit breakers shall be operated by a motor spring charging type of mechanism. The mechanism shall be complete with motor, opening spring, closing spring and all accessories to make the mechanism a complete operating unit.
- Operatingmechanismshallnormallybeoperatedfromthebreakercubicle itself.
- The tripping spring shall be charged by the closing action, to enable quick tripping. Closing of the circuit breakershallautomaticallyinitiate rechargingof thesprings toenablethe mechanism to be ready for the next

closing stroke. Charging time for the springs shall not exceed 30 seconds. It shall be possible to manually charge the springs in an emergency. Transfer from motor to manual charging shall automatically disconnect the charging motor. All operating mechanisms shall be provided with "ON" - "OFF" mechanical indication. The charging mechanismshallbeprovidedwithmechanicalindicatorstoshow"charged"and"discharged"

conditions of the spring. Failure of any spring, vibration or mechanical shock shall not cause tripping or closing of the circuit breaker.

- Onlyone closingoperationof the circuit breaker shall result fromeach closingimpulse (manual or electrical), even if the breaker trips while the control device (manual or electrical) shall be being held in the "close" position.
- Thecircuit breakermechanismshall make one complete closingoperation, oncethe push button (PB) or control switch has been operated and the first device in the control scheme has responded, even though the PB or control switch shall be released before the closing operation shall complete, subject to the condition that there is no counter-impulse for tripping.
- Means shall be provided to manually open and close the breakers slowly, when the operating power shall not be available, for maintenance and adjustments. A local manual trip device shall also be provided on the operating mechanism.
- Circuit breaker control shall be on 110V DC. Closing coils and other auxiliary devices shall operate satisfactorily at all voltages between 80 - 110% of the control voltage. Trip coils shall operate satisfactorily between 50 - 110% the rated control voltage.

SafetyInterlocksandFeatures

- Withdrawal or engagement of a circuit breaker shall not be possible unless itshall be in theopen position.
- All circuit breaker shall have lockable local / off / remote selector switch, for closing thebreaker from local shall be possible in both TEST / SERVICE position. Closing from remote shall be possible in either SERVICE and TEST position. For opening breaker from local shallbe possible only when local / off / remote selector switch shall be in local position. Opening breaker from remote shall be either breaker in service position or selector switch being inremote position.
- All Motors and ServiceTransformers feeder breaker shall have lockable emergencypush button (openableonlywithkey)nearmotorandservicetransformer,hardwiredtocircuit breakerpanel emergency push button.
- Operation of a circuit breaker shall not be possible unless it shall be in service position, withdrawn to test position or fully drawn out. It shall not be possible to close the circuit breaker electrically in the service position, without completing the auxiliary circuit between the fixed and moving portions.
- Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationary isolated contacts when the breaker shall be withdrawn. Padlocking facilities shall be provided for locking the shutters positively in the closed position. It shall, however, be possible to open the shutters intentionally against spring pressure for testing purposes.
- The circuit breaker carriage shall be earthed before the breaker reaches the test position from fully withdrawn position. In case of breakers with

automatic disconnecting type of auxiliary disconnects, the carriage shall be earthed before the auxiliary disconnects are made and the carriage earthing shall break only after the auxiliary disconnects break.

- Caution nameplate, “Caution Live Terminals” shall be provided at all points where theterminals are likely to remain live and isolation shall be possible only at remote end, i.e., incomer to the switchboard. Suitable interlock shall be wired for the purpose.

- The switchboard shall have passed internal arc testing for 1 second at the rated switchgear fault current. Pressure relief flaps shall be provided at the top of the switchboard with suitableexhaust arrangement to release hot over-pressurized gases in case of an internal fault. The internal arc time could be 0.5 sec or 0.1 sec at switchgear rated fault current in case rapid fault clearance time initiated by detectors sensitive to light, pressure or heat or by bus bar differential protection is provided.

Earthing

Copperearthingbusshallbeprovidedandextendedthroughoutthelengthoftheswitch board.Itshall be bolted to the framework of each unit and brazed to each breaker earthing contact bar. It shall be located at the bottom of the board. The earth bus shall have sufficient cross section to carry the momentaryshortcircuitand shorttime faultcurrent for atleast1 second or higherwithout exceeding maximumallowabletemperaturerise.The earthbusshallbe properlysupportedtowithstand stresses induced by the momentary short circuit current.

Suitable clamp type terminals at each end of the earth bus shall be provided to suit the size of the earthing conductors. Bolted joints, slices, tap, etc. to the earth bus shall be made with at least two bolts.Positiveearthingofcircuitbreakerframeshallbemaintainedwhenitshallbeinth econnected position and in all other positions whilst the auxiliary circuits are not totally disconnected.

Hingeddoorsshallbeearthedthroughflexibleearthingbraidof adequatecrosssection.Allnon- current carrying metal work of the switchboard shall be effectively bonded to the earth bus.

Positiveconnectionoftheframesofalltheequipmentmountedintheswitchboardtothe earthbusbar shall be maintained through insulated conductors of size equal to the earth busbar or the load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to earth busbar bymeans of 1100V grade, green coloured,PVCinsulated,stranded,tinnedcopper,2.5sq.mmconductorloopedthroug heachofthe earth terminals.

Circuit/BusbarEarthingFacility

It shall be possible to connect each circuit or set of 3 phase bus bars of the switchboard to earth throughearthingswitches.Earthingswitches/earthingdevicesshallbemechanicallyi

nterlockedwith the associated breakers to prevent accidental earthing of live circuit or bus bars.

In case the earthingfacilitycomprisesearthingtrucks to be inserted inplace of circuit breakers, separate earthing trucks shall be supplied for each type / size of breaker. The earthing facilities proposedtobeprovidedbytheBiddershallbeclearlydetailedintheBidandshallbesubject to

Employer'sapproval.Auxiliarycontacts(min.2NO+2NC)shallbeprovidedoneachearthswitch/ earthing device and shall be wired to the terminal block for interlocking purpose.

Annunciators

Annunciators shall be of fascia type with translucent plastic window for each alarm point. Annunciated fascia plates shall be engraved in block lettering with respective alarm inscriptions. The inscriptionsshall be clearlyreadable and visible whentherespective fascia LEDlight shall belighted. EachannunciationwindowshallbeprovidedwithtwoLEDlightstoprovideredundancyagainstLED light failure. Lamps shall be replaceable from the front. Lamps shall be of clustered LED type.

All fascia annunciated points shall be suitable to accept external contacts of either ‘NO’ or ‘NC’ selforhandresettypeforinitiatingtheannunciationsequenceshallbesuitableforacceptingfleetingfaults of duration as less as 15 milliseconds.

For staticannunciator schemes, special precautionshall be taken bythe contractor toensurethat spurious alarm conditions do not appear due to influence of external magnetic fields on the annunciatorwiringandswitchingdisturbancesfromtheneighbouringcircuitswithinthepanels/ desks.

A “Lamp Test” push button shall be provided for each individual panel’s group of annunciators to limit the sudden drain on the battery. Provision of testing facilities for flasher and audible electronics alarmcircuitsofannunciatorsisdesirable.TheContractorshallgivethedetailsoftheofferedscheme.

Annunciatorshallhavefollowingfeatures:

- Suitableforannunciatingsubsequentfaultsimmediatelyafterthesoundcancelof the previous fault.
- During lamp test, if a fault occurs, the corresponding lamp circuit shall be automaticallydisconnected from the “lamp test” circuit and shall start flashing.
- Designed to prevent mal operation of the scheme or sequence when the push buttons arepressed incorrectly or in the wrong order.
- "Alarm SupplyFailure”Alarm schemesimilartothenormalannunciationsequencebut shall operate on a different DC supply or on AC auxiliary supply.
- Alarmannunciateshavingprovisiontointegrateallalarm/tripsignalstoPLC.
- Alarmannunciationshallbeprovidedfortransformers,Chlorinationsystemandsurge vessel system wherever discrete local automation shall be envisaged.
- AllAnnunciationsshallhaveinterfacingfacilitieswithcommunicationforSCADA.

IndicatingInstruments&Meters

Theinstrumentsshallbeelectronic/ digitaltypewithLCDdisplay.Theseinstrumentsshouldhave high performance ratio and can be equipped with digital output (for alarms) or with interfacing facilities for communication and remote reading of parameters.

- **MeteringInstruments**
- Multi-Function Meter with the facility to measure A, V, kW, kWh, kVAr, PF, kVARh, Hz and Hormonic (%THD) contents with communication port.
- Multi-Function Meters shall be of the accuracy class 1.0, suitable for measurement of unbalanced loads in three phase three wire circuits.
- MFM shall be suitable for operation from the secondary of CTs and VTs. They shall beprovided with a separate 3 phase 4 wire type test blocks for the testing of the meters without disturbing the CT and VT secondary connections.

Theinstrumentscanbeelectronic/ digital typewithLCDdisplay&RS485connectivityforremote readingofparametersinSCADA.Theseinstrumentsshouldhavehighperformancer atioandcanbe equipped with digital output (for alarms).

ControlandSelectorSwitches

Control and instrument switches shall be heavy duty rotary type, provided with escutcheon plates clearlymarkedtoshowoperatingpositionandsuitableforsemi-flushmountingwithonlytheswitch front plate andoperatinghandle projectingout.The connections shall be fromthe back. The contact assembly at the back of the switch shall be enclosed in dust tight removable covers.

Thecontrol switchesshallbe3positions,springreturntoneutraltype.Theyshall beprovidedwith contacts to close in ‘normal after close’ and ‘normal after trip’ position. Each switch shall have external red and greenindicatinglamps, (except whendiscrepancytype switches are calledfor). In addition,asemaphoreindicatorshallbeprovidedforearthingswitch.Local/Off/ Remoteselector switch shall be stay put 2 / 3 position with lockable provision.

Contacts of the switches shall be spring assisted and contact faces shall be of silver / silver alloy.
Springsshallnotbeusedascurrentcarryingparts.Contactratingandconfigurationsof theswitches shall be adequate for the functions desired.

Lockable type switches, which can be locked in a particular position, shall be provided, if required. Emergencystopbuttons,ifany,shallincorporate‘stay-put’featureswithindependentresetfacilities.

IndicatingLights/PilotLights

Indicatinglightshallberatedforoperationateither230V ACoratthespecifiedDCsystemvoltageas applicable. Lights shall be provided with translucent light covers.

ClusteredLEDtypelampsshallbeprovided.Lensesshallbeglassorplasticinstandard colours,red,
green,blue,whiteandamber,inaccordancewithIEC60073.Miniaturepilotlampsma ybeprovided with plastic markingplatecontainedinsidesquare(orrectangular)

front lensto provide indication of legend or symbols engraved on the marking plate.

Thebasisofcolorsshallbeasfollows:

Red : Flow of energy.

Green : Noflowofenergy.

White : Supervisionofpoweravailable,relaycoilhealthy, etc.

Amber : For all alarm conditions such as pressure low, overload, Disagreement with originalcondition,‘abnormal’conditionor‘sequence-on’conditionalsoforserviceandtestposition.

Blue :

Forallhealthyconditionssuchascontrolsupply,spring charged and lockout relay coil healthy.

Yellow : ForR,Y,Bindicationlight,yellowasoneofthelights.

PushButtons

Pushbuttonsshallbeofmomentarycontacttypewithrearterminalconnections.Th ecolourofthe push button actuator shall be red for ‘OPEN / STOP’ and green for ‘CLOSE / START’.The push buttonknobshallbesuitablyshroudedtopreventinadvertentoperation. Thepushbuttonsshall be provided with integral inscription plates engraved with their designation.

Normal stoppushbuttonshallbemushroomtypelatchableinredcolour,afterpressinganditsha llbe latched, and latch can be removed by clockwise rotation (Motor stops automatically after predetermined conditions such as delivery valve close in case of pumps). This may replace stop push button.

Emergency stop push button red in colour shall be lockable by pressing the push button and can be openingonlywithkeyandwithshrouding. (Motorstoppedimmediatelyirrespectiveofpredetermined conditions required) Emergency Push button with shrouding shall be provided near transformer and motors for remote tripping.

Resetpushbuttonshall beeitherforresettingtheflagandOLRorLEDswithpushbuttonfor resetting.

All push buttons shall have independent, potential free, 2NO + 2NC contacts. The contact faces shall beofsilver /silver alloy.Thecontactsshall berated10Aandcapableofbreakinginductiveloadof5A at 110V DC.

AllpushbuttonshallhaveadditionalNO/ NCpotentialfreeforhardwiringtoinstrumentationcontrol panel.

Space Heaters

Adequatelyratedanti-condensationspaceheatersshallbeprovidedforeachswitchboard/cubicle,bus ducts. Space heater shall beof the industrial strip continuous dutytype, ratedforoperation on a240V, 1 phase, 50Hz, AC system.

SpaceheatershallbeprovidedwithasinglepoleMCBwithoverloadandshortcircuitrelease,a neutral link and a RTD thermostat to cut off the heaters at 35-degree C.

CubicleLighting/Receptacle

Each cubicle shall be provided with interior lighting by means of 18 W energy efficient (lumen per wattshall be indicated) LED lightingfixture.An MCB shall beprovided for the lightingcircuit.The lightingfixtureshallbesuitableforoperationfroma240V,1ph,50Hz,ACsupply.A240V,1phase, AC receptacle (socket) plug point shall be provided in the interior of each panel with an MCB.

Powerand ControlCable Termination

Terminals for power connections shall be complete with adequate phase segregating insulating barriers, shrouds and suitable aluminium solder less crimping type of lugs for terminating the cables and control cables lugs and ferrules shall be tinned copper confirming to IS 8309. The cable lugs for controlcablesshallbeprovidedwithinsulatingsleeveandshallsuitthetypeofterminationprovideon the equipment.

Double compression type glands with armour and bonding clamps for the termination of all solid dielectric multicore cables shall be provided and shall confirmto BS:6121. They shall be designed to secure the armour wires to provide electrical continuity between the armour and the threaded fixing component of the gland and to provide watertight seals between the cable outer sheath and gland and betweentheinnersheathandthreadedfixingcomponent.Theglandshallpreferablyprojectabovethe gland plate (non-magnetic material) to avoid entry of moisture.

Earthing connectors between cable armour and earth shall be routed outside the cable gland in an approvedmanner.Glandinsulationshallbecapableofwithstandingtestforappropriatehighvoltage for one minute.

CableterminationsforHV/MVcablesshallbeheat/coldshrinkabletype.Adequatelysized shrouds /boltsshallbeprovidedatconnectionstocompletelycoverthe terminations.

Wherecorebalancetypecurrenttransformersareprovidedonthefeedercablesforeart

hfault protection, glands for cables shall be insulated from earth in an approved manner.

WiringforControl andProtective Circuits

All lowvoltage wiringforcontrol,protection and indication circuitsshall be carried out with 1100V grade,PVCinsulatedcablewithstranded,tinnedcopperconductorofminimum1.5sq .mmsize. The size of conductor for CT circuits shall be minimum 2.5 sq. mm.

All wiringshall berunonthesidesofpanelsandshallbeneatlybunchedandcleatedwithoutaffecting access to equipment mounted in the panel. The wiring shall be bound and supported by clamping, roughing or lacing. Spiral wrapping shall not be accepted. Wireways shall not be more than 50% full. Adequate slack wire shall be provided to allow for one re-stripping and reconnection at the end ofeachwire.Whenscreenedcablesorwiresarenecessary,aninsulatingsheathshallbe included.Wiring and supports shall be of fire-resistant material.

Wiringshallonlybejointedortiedatterminals.Terminalsoftheclamptypeshall nothavemorethan two wires connected.

TerminationandFerrules

Engravedcoreidentificationferrules,markedtocorrespondwiththewiringdiagram,s hallbefittedto each wire and each core of multicore cables terminated on the panels.

Moistureandoilresistinginsulatingmaterialshallbeused.Theferrulesshallbeofthein terlocking type and shall grip the insulation firmly without falling off when the wire shall be removed.

Allwiresformingpartofatrippingcircuitshallbedistinctivelymarked.Spareauxiliaryc ontactsof electrical equipment shall be wired to terminal blocks.

ControlWiringTerminalBlocks

Terminalblocksshallbeof1000Vgrade,10Aandstudtype.Brassstudofatleast6mmdia .withfine threads shall be used and securely locked within the mounting base to prevent turning. Each terminal shallcomprisetwothreadedstuds,withalinkbetweenthem,washers,andmatchingnu tsandlocknuts for each stud. Connections to the terminals shall be at the front.

Terminalsshallbenumberedforidentification,groupedaccordingtofunction.Engrav ed‘blackon- white’ labels shall be provided on the terminal blocks describing the function of the circuit.

Terminalsforcircuitswithvoltageexceeding110Vshallbeshrouded.Terminalblocksa tdifferent voltages shall be segregated into groups and distinctively labelled. Terminals used for connecting current transformer secondary leads shall be ‘disconnecting and shorting’ type with a facility for earthing the secondary.

Terminal blocks shall be arranged with 100 mm clearance, between any two sets. Separate terminal stemsshallbeprovidedforinternalandexternalwiringrespectively.Allwiringshallbeterminatedon terminal blocks, using crimping type lugs or claw type of terminations.

At least 20% cores shall be kept spare in multicore control cables. At least 10% spare terminals shall beprovidedandspaceforaddinganother10%sparesterminalsshallalsoavailableineachset ofTBs.

BusBars

The Bus bars shall be of electrical grade, high conductivity, copper and shall be provided with minimum clearances as per relevant IS. Bus bar cross section shall be uniform throughout the length oftheswitchgear.Allbusbarsandbustapsshallbeinsulatedwithclosefittingsleeveofhard,smooth, dust and dirt free,heat shrunkPVC insulation ofhigh dielectric strength, to provide a permanent non- ageing and non-tracking protection, impervious to water, tropical conditions, and fungi.

Theinsulationshallbenon-inflammableandself-extinguishingtypeandinfastcolourstoindicate phases. The dielectric strength and properties shall hold good for the temperature range of 0 to 95 degree centigrade. If theinsulatingsleeve isnotcolour,bus bars shall be colourcoded with colour PVC tape at suitable intervals for easy identification.

Busbar joints shall be of the bolted type. Spring washers shall be provided to ensure good contact at thejoints.Busbarsshallbethoroughlycleanedatthejointsandsuitablecontactgreasehallbeapplied just before making a joint. Direct access to, or accidental contact with busbars and primary connections shall not be possible.

Allaperturesandslotsshallbeprotectedbybafflestopreventaccidentalshortingofbusbarsdueto insertion of maintenance tools.

Sequenceofred,yellowandbluephasesandneutralforfour-poleequipmentshallbelefttorightand top to bottom, for horizontal and vertical layouts respectively.

EndterminationsattransformerendandMVpanelendshallbeflexiblebusbarsuchthatnoload/ force / weight of the bus bar act on the terminal studs.

Current&Voltage Transformers

Current transformers shall be of cast resin, bar primary type unless specified otherwise, suitable for continuousoperationattheambienttemperatureprevailinginsidetheswitchgearenclosureandshall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block. The class of insulation shall be Class E or better.

Currenttransformersshallbeabletowithstandthethermalandmechanicalstressesresulting fromthe maximum short circuit and momentary duties of the switchgear. For wound primary type CTs, the short time current rating shall not

be less than 0.5 sec. CT core laminations shall be of high-grade silicon steel. Where multi ratio current transformers are specified, a label shall be provided, clearly indicating the connections required for the alternative ratios.

Theseconnectionsshallalsobeshownonpanel wiringdiagrams.Identificationlabelsshallbefitted givingtype,ratio,rating,outputandserialnumbersandduplicateratinglabelsaretobe fittedonthe

exteriorofthemountingchamberssuitablylocatedtoenablereadingwithouttheremovalofanycover or metal sheeting forming part of the structure of the switchboard.

Magnetizationcharacteristicscalculatedperformanceandprotectivesettingsshallbeprovidedbythe contractor.AllVoltageTransformersshallbeofSingle-Phasetype.ThebusVTsshallbehousedina separate panel in a truck so as to be fully with drawable. All Voltage transformers shall have HRC fuses / MCBs on Primary and MCBs on Secondary Side. There shall be provision for changeover on secondary side of Voltage Transformers to have alternate arrangement in case one Voltage Transformer fails.

Relays

(a) All Protective relays shall be numerical type except aux. relays. Numerical relays shall have appropriate settingranges, accuracy, resettingratio,transient overreach and othercharacteristics to provide required sensitivity.

(b) All numerical protective relays shall be flush mounted at the front with connections at the rear. Shall have communication port for remote, metering and monitoring facility, suitable for electrical measurement including voltage, current, power (active / reactive) and energy parameters.

(c) All numerical relays shall have keypad to allow relay settings from relay front. Resetting knobs shall be accessible from the front on removing the external cover and shall be external to the case.

(d) All numerical relays and timers shall be rated for control supply voltage specified and becapable of satisfactory continuous operation between 70 % and 110 % of the rated voltage. Making, Carrying and Breaking Current ratings of the relay contacts shall be adequate for the circuits in which they are used.

(e) The numerical relays shall have communication, metering and monitoring facility. The communication facility shall have two Ports local front port (RJ45/USB) for laptop communication and the second port Rear RS485 for SCADA.

(f) The numerical processor shall be capable of measuring and sharing values of a wide range of quantities, events, faults and disturbance recordings with time stamping using internal real time clock. Battery backup for real time clock in the event of power failure shall be provided.

(g) Numerical Relays shall have diagnostic feature with self-check for power failure,Programmable routines, memory and main CPU Failures etc.

(h) The Protective relays shall have adequate number of potential free contacts (Programmable). The Contacts shall be suitable for directly wiring in the breaker closing and tripping circuits operating from 110V DC Control Voltage.

(i) The current operated relays shall have provision for 4 Sets of CT Inputs and Voltage operated relays shall have provision for 3 PT inputs. Relays shall be suitable for CT secondary current suitable for CT Secondary current of 1A / 5A selectable at Site.

(j) Numerical Relays shall be immune to any kind of electromagnetic

interference and capacitance effect due to length of connected control cables.

(k) TimerfunctionshallbeprogrammableforON/OFFdelays.

(l) Numerical Relays shall be able to provide supervisory function such as trip circuit monitoring, circuit breaker monitoring, PT & CT supervisions and recording facilities with post fault analysis.
(m) Allrelaysshallwithstandminimumtestvoltageof2kVACRMSforone minute.
(n) Numerical relays shall have two level password protections, one for read only and other for authorization for modifying the setting etc.

Energymonitoringandpowersupplymanagement

Necessary provisions & features shall be incorporated to enable energy monitoring / energy managementfortheinstallation.EnergyMeteringshallmeettherequirementofguaranteedspecific energy consumption specified by the contractor through instrumentation control system.

Incase,Numericalrelayshavingbuiltinfeaturesofenergymeasurementofrequisiteaccuracyand provided in switch gear, separate energy meter shall not be required.

Necessaryprovision&featuresshallbeincorporatedtoundervoltagemonitoring/ relayforincomer feeder, busbar chamber and control supply.

I/ OsignalforInstrumentation,Control&AutomationSystemfromElectrical panels.

I/ Osignalsfrominstrumentsshallbeseparatelywiredtoamarshallingboxsuchthatinstrumentation engineers shall not enter into power panel that are not familiar with them.

Necessaryprovisionsshallbeincorporatedtomeettherequirementsindicatedin:

(a) I/OSchedules–ACB/ VCB,CommandOpen&Close,Feedbacktrip,Breakerhealthy (Ready to close), Local / Off / Remote, Breaker Opened / Closed, Breaker Test / Service Position.
(b) DataTransfer Schedule
(c) Alarm Schedule of Particular requirement of Instrumentation, Control & Automation System, Part-13, and Volume 2 of the Bid document.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

415VMetalEnclosedSwitchgears(PCC/MCC)

415VMetalEnclosedSwitchgear(PCC/ MCC)systemshallhaveprovisionsuchthatinter-opera abilitywithinstrumentationcontrolssystem.MCC/PCCpanelboardsshallbeoffer edforfinal inspection at the OEM’s works with routine tests.

ApplicableStandards

Theswitchgearandcomponentsshallconformtothelatestapplicablestandardsspecified below.

SwitchgearGeneralRequirements	IS:13947/BS:5486/ IEC:60947
FactoryBuiltAssembliesofSWGRandControlgear for Voltages up to and including 1000V AC & 1200V DC	IS:8623/BS:5486/IEC:60439-1
AirCircuitBreakers(ACB)	IS:13947-Part(1&2)/BS EN:60947 / IEC:60947
Low-voltageSwitchgearandControlgearassemblies	IEC:61439–1&2
MouldedCaseCircuit Breaker	IS:2516 / IEC 60947-2 / BS EN:60947-2/IS:13947-Part(1&2)
MiniatureCircuitBreakers	IS:8828/ BSEN:60898
Lowvoltage Fuses	IS:13703/BS:1362/ IEC:60269-1
Contactors	IS:13947/BSEN60947-4/ IEC:60947 -1
Starters	IS:13947/BSEN60947–4/ IEC:60292-1to4
ControlSwitches/Pushbuttons	IS:6875/ BSEN60947
CurrentTransformers	IS:2705/ BS:7626
VoltageTransformers	IS:3156/BS:7625/IEC:60044, 60186
Indicatinginstruments	IS:1248/BS:89/ IEC:60051
Electricalrelays.	IEC:60255

MarkingandIdentificationofConductorsandApparatus Terminals	IS:11353/BS:159
A.C.ElectricityMeters	IS:722,8530/BS:5685/ IEC:60145, 60211
Degreeof Protection	IS:13947/IEC:60947- P1
Selectioninstallationandmaintenanceofswitchgearand control gear	IS:10118
Codeofpracticeforphosphatingcoatedironandsteel	IS:6005/ BS:3189
Specificationforcopperrodsandbarsforelectrical purposes	IS:613
Controltransformersforswitchgearandcontrol gear voltage not exceeding 1000V AC	IS:12021
ClassificationofHazardousareashavingFlammable gases and vapours for Electrical Installation	IS:5572
GuideforSelectionofElectricalEquipmentfor Hazardous areas	IS:5571
Electricalapparatusforexplosivegasatmospheres- General Requirements	IEC:60079
BasicandSafetyPrinciplesforMan-MachineInterface, Marking and Identification - Coding Principles for Indicators and Actuators.	IEC:60073
ConductorsofInsulated Cables.	IEC:60228
Dimensions of low-voltage switchgear and Control gear. Standardizedmountingonrailsformechanicalsupportof electricaldevicesinswitchgearandControlgear installations.	IEC60715
Graphicalsymbolsforuseon equipment.	IEC:60417
Electricitymeteringequipment	IEC:62052-11/IEC62052-21
Emptyenclosuresforlow-voltageswitchgearandControl gear assemblies General requirements and Control gear assemblies General Requirements	IEC:62208

General

The LV switchboards shall be type tested assemblies (TTAPanels) inall respectsbe suitable for operationsinserviceconditionsandwithstandingthestressestotheseismicconditions.Theoffered designshallmeettherequirementsofIEC60068-2-57,&IEC60068-3-3.Necessarytypepestreport

fromanindependentinternationallyaccreditedtestlaboratoryshallbefurnishedtoest ablishthatthe offereddesignperformssatisfactorilyincompliancetothereferencestandards.

The LV switchboards shall be type tested assemblies (TTA) fully meeting the requirements of IEC 61439 – 1 & 2 for design verified assemblies. The eligible switchboard suppliers shall be Original EquipmentManufacturer(OEM)onlywiththeirownrangeofACBs,MCCBs,PowerCon tactors& otherswitchgeardevices.Theswitchboardsshallbe manufactured,design&testedbyOEMattheir own works.

The LV main switchboards and the associated equipment, including switchgear, control gear and bus bar assemblies shall be certifiedfor the categoryof dutyspecified. TheLV MainSwitchboard shall be identical in mechanical construction to the LV Switchboard which had been type-tested by an acceptable,multifolddesignforstructuralmembers(9-folddesign)withimpacttestasperIEC62262, accredited and independent testing laboratory for the fault conditions, temperature rise limits. Any manufacturer not having the above will not be considered for supply. The main circuits ofthe LVmain switchboards shall have an insulation voltage of 1000 V AC. Panels shall be tested to withstand internal arc fault of 50kA, 0.4 seconds and valid Type Test Certification shall be provided as per IEC61641.

Thedesigntemperaturefortheequipmentprovidedinthemainlowvoltageswitchboardssh allbe+45 ^{0}C.Therelativehumidityshallbe75%atatemperatureof+45^{o}C.

Where armoured multicore cables terminate inside the switchboard enclosure, glanding plates or glanding brackets shall be provided for securing the cables to the switchboard. Glanding plates, glanding brackets and extension boxes shall be removable and shall be of adequate size for the particularcablestobeterminated.Separatecurrenttransformersshallbeprovidedfor each protection device and for instrumentation. The switchgear assembly/ sub-assemblies or panels shall be termite and rodent proof. The sub-assemblies of similar equipment shall be interchangeable.

Switchboards(TTA) shallalsohaveSeismicwithstandcapability.

The offered switchboard along with Incomer ACBs / MCCBs and outgoing feeders with all interconnections shall be as per type tested design of OEM at CPRI / ERDA / Independent internationaltesthouseforshortcircuit,temperaturerise,protectiveearthshortcirc uittestand dielectric tests of the ratings required.

ForoperatorsafetyIP2X(touchproof)protectiontobeavailableevenafteropeningthe feeder compartment door.Thecompartmentalizationtobeachievedbyusing metalorFRPseparators,useof PVC sheet / Hylem sheets shall not be allowed.

TheSwitchboards shallbeof adequatesize with a provisionof sparespace toaccommodatepossible future additional switch gear.

FeaturesofConstructions

(a) Theswitchgearshallbemetalenclosed,dustproof,modulartype,suitableforindo orfloor mounting and shall have following features:

(i) Total height of switchgear shall not exceed 2300 mm. Height of Switches, push buttons shall not exceed 1800 mm and shall not be less than 600 mm.
(ii) Shallbesinglefrontexecutionandfixedtype.
(iii) Shallhavedesignationlabelsbothonfrontandrear sides.
(iv) Shall be provided with proper gasketing for removable covers, doors, between panels and base frame and all around the perimeter of adjacent panels.
(v) DegreeofProtectionshallbeIP54forindoor&IP65for Outdoor.
(vi) ThicknessofCRCASheetthepaneldoorsshallbe2.5mmoroverandforthere stshallbe 2.0mm.
(vii) Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidec overs.
(viii) ShallfollowIS5572/ IEC60079,standardspecificationandstandardpracticefor installation in Hazardous area.

(b) Switchgearshallbedividedintodistinctverticalsectionseachcomprising:
(i) Acompletelyenclosedbusbarcompartmentrunninghorizontally.
(ii) Enclosedverticalbusbarsservingallmodulesinvertical section.
(iii) Aseparatehorizontalenclosureforallauxiliarypowerandcontrolbuses,if required.
(iv) Verticalcablealleyof250mmwidecoveringentireheight.
(v) Operatingdevicesshallbeincorporatedonlyinthefrontofswitchgear.
(vi) Eachshippingsectionshallhavemetalsheetsatbothends.
(vii) Cablealleyshallbeprovidedwithsuitablehinged doors.
(viii) GSEarthbusofsize50mmx10mmshallbeprovidedatthebottom.
(ix) Alldoorsshallbewithconcealedtypehingesandcaptivescrews.
(x) Each vertical section shall be equipped with 240V, 1Phase, 50Hz space heater controlled by thermostat.
(xi) A 240V, Phase, AC plug point shall be provided in the interior of each cubicle with on- off switch for correction of head lamps.
(xii) 20% spare feederswith at leastone for each typeof highest rating shallbeprovidedin each switchgear.
(xiii) Interchangeability- Allidenticalequipmentandcorrespondingpartsbefully interchangeable without any modifications.

(c) MainandAuxiliaryBuses
(i) Switchgear busbars shall be of uniform cross section throughout the length and made of high conductivity, electrical grade hard drawn copper conductor with 1.40Amp / Sq.mm current density throughout the length.
(ii) All busbars shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non- ageing and non-tracking protection, impervious to water, tropical conditions and fungi.
(iii) Busbar joints shall be provided with contact grease at the joints and shall be complete with tensile steel bolts and belleville washers and nuts.
(iv) All sheet steel work shall be phosphate coated in accordance with the followingprocedure and in accordance with IS: 6005 “Code of Practice

for Phosphate coated Iron and Steel". Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

(v) After phosphate coated, thorough rinsing shall be clean water followed by final rinsing with dilute dichromate solutionand even drying. The phosphate coatingshall be followed

by the application of two coats of ready mixed stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved. After application of the two coats of primer finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests. The final finished thickness of paint film on steel shall not be less than 80 microns and shall not be more than 120 microns.

(vi) Finished painted surface of panels shall present an aesthetically pleasing appearance free from dents and uneven surface.

(vii) Asmall quantityoffinishingpaint shall besuppliedforminortouchinguprequiredat site after the installation of the panels.

(d) The equipment shall be arranged within each compartment such that all normal maintenance canbecarriedoutthroughhingedaccessdoorsorremovablecovers,andwherepossible from the front. The switchboard shall have a rated shorttime withstand currentas per SLD andafaultwithstandforasupplyvoltageof(415V)AC between phases at 50Hz.

(e) Protection against shock in normal service shall be achieved by the provision of barriers or enclosures both vertical and horizontal and between adjacent units to ensure segregation and prevent accidental contact with live parts, or by complete insulation of all live parts. Control cables shall be segregated from primary conductors.

(f) Switchboard construction shall employ the principle of compartmentalized and segregationfor each circuit.

(g) Incomerandbussectionpanelsorsectionsshallbeseparateandindependentand shallnot be wired with sections required for feeder

(h) Switchboard shall be readily extensible on both sides by addition of vertical sections after removal of the end covers.

(i) Special care to be taken to ensure effective earthing of the frame and doors of the switchboards. All metallic parts shall be effectively connected a protective earth system in the switchboard to ensure positive earthing at all times.

(j) Allpanelsandcoversshallbeproperlyfittedandsquarewiththeframe.Theholesin the panel shall be correctly positioned.

(k) Switchboard shall be provided with “Danger Notice Plate” conforming to relevant Indian Standards.

(l) TheLVswitchboardsshallbemountedonarobustbaseframemadeupofsteelchannelswitha minimum height of 100mm. The base frame shall be able to withstand thestatic and dynamicloads oftheLVswitchboards.Thesteelchannelsshallbepaintedwithepoxy polyster paint.

(m) For compartmentalized switchboards, separate totally enclosed compartments shall be provided for horizontal busbars, vertical busbars, ACBs, MCCBs, and cable alloys.

(n) Cable compartments shall be of adequate size for easy termination of all

incoming and outgoing cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

AirCircuitBreaker (ACB)

(a) Aircircuitbreakershallbeselectedforfeedersforloadcurrentmorethan630A.

(b) Circuit breakers shall be operated by a motor spring charging type of mechanism. The motor operated spring charged mechanism shall be complete with motor, opening spring, closing spring and all accessories to make the mechanism a complete operating unit.

(c) The tripping spring shall be charged by the closing action, to enable quick tripping. Closing of the circuit breakershallautomaticallyinitiate rechargingof thesprings toenable the mechanism to be ready for the next closing stroke. Charging time for the springs shall not exceed 30 seconds. It shall be possible to manually charge the springs in an emergency.

(d) Transfer from motor to manual chargingshall automaticallydisconnect the charging motor. The charging mechanism shall be provided with mechanical indicators to show "charged" and "discharged" conditions ofthe spring. Failure of anyspring, vibration or mechanical shockshall not cause tripping or closing of the circuit breaker.

(e) Onlyone closingoperationof the circuit breaker shall result fromeach closingimpulse(manual or electrical), even if the breaker trips while the control device (manual or electrical) is being held in the "close" position.

(f) Thecircuit breakermechanismshall make one complete closingoperation, oncethe push button has been operated and the first device in the control scheme has responded, even though the PB shall be released before the closing operation shall be completed, subject to the condition that there is no counter-impulse for tripping.

(g) Means shall be provided to manually open and close the breakers slowly, when the operating power shall not be available, for maintenance and adjustments. A local manual trip device shall be provided on the operating mechanism.

(h) All operating mechanisms shall be provided with "ON" - "OFF" - "TRIP" mechanicalindication.

(i) Closing coils and other auxiliary devices shall operate satisfactorily at all voltages between 85 - 110% of the control voltage. Trip coils shall operate satisfactorily between 70 - 110% the rated control voltage.

(j) The ACB shall be 4 pole with modular construction, draw out, manually operated. In case of 4 pole version neutral rating shall be 100% of phase.

(k) The Breaker shall be provided with Microprocessor based Protection unit for Inverse-time delayed overload releases for the phases, Short-time delayed short-circuit releases and earth- fault releases.

(l) The breaker service Short Circuit breakingcapacity(I_{CS}) shall be equal to ultimate Short Circuit capacity (I_{CU}) and shall be equal to short time withstand current of Breaker (I_{CW}).

(m) ACB shall be provided for Incoming side of the PCC / MCC from transformer irrespective of rating of feeder.

(n) The cradle shall be so designed and constructed as to permit smoothwithdrawal and insertionof the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls / rollers and not on flat surfaces.

(o) ThereshallbeprovisionforlockingthebreakerinanyofService,TestorIsolatedpositions.

(p) ACB shall be supplied with 4 auxiliary contacts (combinations of NO / NC shall be selected at site) and 1 tripcontact.Ifneed arise there shall be

facility toadd additional auxiliary contacts(6 no’s).

(q) ACB shallhaveprovisiontouse`ReadytoClose’contact.

(r) The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

(s) ArcChutecoverswherevernecessary shallbe provided.

(t) ACB shall have a Ready to close indication contact which shall be used to give a single indicationviaindicatinglampsonpanel doorifACBisreadytobeclosed,aftercheckingall the given conditions ensuring safety for user and electrical distribution.

IntelligentMotorProtectionRelay

The intelligent motor controller for 3-phase AC induction motors combining the two classical functions of motor protection and motor management in a single device plus offering diagnostic and fieldbuscommunication.Thedevicefunctionsshallbeadjustedinawiderangetocover theneedsof different applications.

ProtectionFunctions:

Itshallbeprovidedmotorprotectionincludingphasefailuredetection,adjustablemotorprotectionfor stalled motors during start up or normal operation, configurable current limits to generate trips or warnings with following features:

(a) Overloadclasses.
(b) Thermistormotorprotection(PTC).
(c) Earthfaultdetection.
(d) Powerandvoltage-basedprotectionfunctions.
(e) Supervisionofthenetworkquality(TotalHarmonicDistortion)

FieldBusCommunications:

(a) It shall be integrated into different fieldbus networks such as PROFIBUS DP, Device Net MODBUS and CAN open via the Fieldbus Plug interface. All measured data, status signals and parameters shall be accessed via fieldbus.
(b) Itisalsopossibletousetheasastand-alonedevicewithouttheFieldbusPlugcommunication.
(c) Themotorprotectionandmotormanagementisfullyfunctionalintheeventofabus failure

Parameterisationoftheprotectionandcontrolfunctionscanbecarriedoutwiththedevicedescription files as defined by the different fieldbuses (e.g. GSD for PROFIBUS). In addition, a Device Type Manager (DTM) offering a very convenient device configuration via a laptop or within a control system is required.

MotorManagement,InputsandOutputs

It shall be provided six digital inputs, three relay outputs and one 24 V output. Therefore, a wide number of control functions shall be covered from the base device. If further inputs or outputs are needed, the basic device can be expanded with an expansion module. The relay shall be supported standard configurations are direct starter, reversing starter, star-delta starter, actuator, inching mode andmanymorefeatures.Toexecutecustomerspecificapplications&allowsfreeprogrammingofits internal logic.

Differentcontrolstations(DCS,DI,andOperationPanel)withindividual,adjustablerel
ease opportunities are required.

Metering,MonitoringandDiagnosis

Rapid, comprehensive diagnostics and operating status information shall be available on the on the LCDpanel(cleartextmessages),viafieldbusoronalaptopconnecteddirectlyorvia fieldbustothe relay.

Thefullygraphic,multi-languageLCDpanelallowsconfiguration,controlandmonitoringofthe controller and its inputs and outputs.

Availablediagnosisincludesmotor,busanddevicestatus,maintenancecounterssuch asnumberof starts and overload releases, remaining cooling time, etc.

MouldedCaseCircuitBreaker(MCCB)

All MCCB's shall be of the air break, quick make, quick break and trip free type switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCB's shall be capable of Variable overload adjustment.

MCCBs shallhave an ultimateshort circuit capacitynot lessthantheshortcircuitcurrent Specified. MCCBsshallhaveaserviceshortcircuitbreakingcapacity(I_{CS})isequaltotheultimate short-circuit capacity (I_{CU}).

EachpoleofMCCBshallbefittedwithabi-metallicthermalelementforinversetimedelayprotection and a magneticelementforshort circuit protection. Alternatively, theyshall befitted with a solid-state protection system. Such a protection system shall be fully self-contained, needing no separate power supply to operate the circuit breaker tripping mechanism.

Thermalelementshallbeadjustable.Adjustmentsshallbemadesimultaneouslyona llpolesfroma common facility. Thermal elements shall be ambient temperature compensated.

Electronic/ MicroprocessorTripUnitshallbeequippedwithinternalbatterytopowerthedisplay in no load conditions.

TheMCCBsshallbeprovidedwiththefollowingfeatures:

- Commontripbarforsimultaneoustrippingofallpoles.
- Shrouded terminals.
- Timeforclearingshortcircuitcurrentof20 msec.
- 2 NO + 2 NC auxiliary contacts suitable for switching 24V DC, 10mA PLC Signals with noloss of signal integrity.

MCCBsshallbeactuatedbyanextendedrotary-handlewithpadlockarrangementthatclearly indicates the three distinctive positions: ON, OFF and TRIPPED.

Adjustableoverloadreleasesforthephases,AdjustableShort-timedelayedshort-circuitreleasesand earth-fault releases. Rotary operated mechanism 240V AC Shunt trip Coil has to be provided.

Manually closing mechanism should be accommodated in a Moulded housing of robust and vermin- proof construction.

MCCB shall be provided with double insulation (insulation between front cover and internal power circuits to avoid any accidental contact with live current carrying path with the front cover open). The insulating case shall be made of high strength heat resistant and flame retardant thermosetting insulating material.

Switches

415Vair-breakswitchedshallbeoftheloadbreak,faultmake,groupoperatedtype.Foruseon 3- phase systems, the switches shall be of the triple pole type with a linkfor neutral wire. For use on single phase system, the MCB type switches shall be of the two-pole type.

(a) Switches shall be of the heavy duty, quick make and quick break type. Switch contacts shallbe silver plated, and contract springs shall be of stainless steel. Switch handles shall have provision for locking in both fully open and fully closed positions. Mechanical ON - OFF indication shall be provided on the switches.
(b) Switchesforcontrollingmotorcircuits shallbe oftheloadbreak, faultmake type, andshallbe capable of breaking locked rotor current of the associated motor.
(c) 415Vswitchesandfusesshallbeprovidedwiththefollowinginterlockssothat.
(d) Thefusesarenotadvisableunlesstheswitchshall beinfullyopencondition.
(e) It shall not be possible to close the switch when the cover shall be open, but an authorized person may override the interlock and operate the switch. After such an operation, the cover shall be prevented from closing if the switch shall be left in the ‘ON’ position.
(f) Fuse less system shall be provided in case fuses required, fuses shall be of the HRC cartridge type, mounted on plug-in type of fuse bases. Fuses shall be provided with visible indicators to show that they have operated.
(g) Earthing and neutral lines in main supply circuits shall be of solid silver-plated copper and be of the bolted pattern.
(h) Fusesandlinksfunctionallyassociatedwiththesamecircuitshallbemountedsidebys ide.

MiniatureCircuitBreaker(MCB)

MCBshallbehandoperated,airbreak,quickmake,quickbreaktype.Operatingmecha nismsshallbe mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions.

Eachpoleshallbefittedwithabi-metallicelementforoverloadprotectionandamagneticelementfor short-circuit protection. Multiple pole MCBs shall be mechanically linked such that tripping

of one
polesimultaneouslytripsalltheotherpoles.Themagneticelementtrippingcurrentcla
ssificationshall be of the type suitable for the connected load. Where this shall
not be specified, it shall be Type C. The short circuit rating shall be not less
than that of the system to which they are connected.

Contactors

The power contactors used in the switchboard shall be of, air break, single throw, triple pole, electromagnetictype.Contactorsshallbesuitableforuninterrupteddutyandratedfor ClassAC3duty in accordance with the latest edition of IS 13947.

Operating coils of all contactors shall be suitable for operation on 240V, single phase, 50Hz supply. ContactorsshallbeprovidedwithatleasttwopairsofNOand NCauxiliarycontacts.Contactorsshall not drop out at voltages down to 70% of coil rated voltage. Contactors shall be provided with a three element, positive acting, ambient temperature compensated, time lagged, hand reset type thermal overload relay with adjustable settings. The hand reset button shall be flush with the front door of the control module and shall be suitable for resetting the overload relay with the module door closed.
Relays shall be either direct connected or CT operated. Overload relay and reset button shall be independentofthe"Start"and"Stop"pushbuttons.Allcontactorshallallbeprovidedwi thsingle phasing preventer (SPP).

Motorstartersshallbecompletewithauxiliaryenergymeters,protectiverelays,timersand necessary indications such that inter-operability with the instrumentation system.

CurrentTransformers/ CBCT

(a) CurrentTransformersshallbeCastResin type.
(b) Currenttransformersshallhavepolaritymarkingsindeliblymarkedoneachtr ansformerandat the lead terminations at the associated terminal block.
(c) Current transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary duties of the switchgear, as indicated in the Technical Specification.
(d) CTcorelaminationsshallbeofhigh-gradesiliconsteel.
(e) Identificationlabelsshallbefittedgivingtype,ratio,rating,outputandserial numbers.

IndicatingInstruments&Meters

Allindicationinstrumentsandwatthourmetersshallbeofthedigitaltype andshallhaveanaccuracy of Class 1.0. Digital type ammeters, voltmeters and multifunction energy meters shall have communication port RS485.

IndicatingLights

Indicatinglightsshallbeoftheclusterled type,withlowwattconsumption.Indicatingl ampshallbe rated for operation at either 240V AC or at the specified DC system voltage as applicable. LED shall be provided with translucent lamp covers.
Bulbs and lenses shall be interchangeable and easily replaceable from the front.

Push Buttons

"Start"and"Stop"pushbuttonsshallbecolouredgreenandredrespectively.StopPushButtonshall be lockable stay-put type with Mushroom head without key or Emergency push button lockable in OFF position and open able only with key.

SpaceHeaters

Adequately rated anti-condensation space heaters shall be provided, one for each control panel, for each switchboard and for each marshalling kiosk. Space heater shall be of the industrial strip continuous duty type, rated for operation on a 240V, 1phase, 50Hz, AC system. Each space heater shallbeprovidedwithasinglepoleMCBwithoverloadandshortcircuitrelease,aneutrallinkanda control RTD thermostat to cut off the heaters at 35 Deg. C.

Safety Arrangements

Allterminals,connectionsandothercomponents,whichmaybe“live”whenfrontaccess door shallbe open, shall be adequately screened. It shall not be possible to obtain access to an adjacent cubicle or module when any door shall be opened. Components within the cubicles shall be labelled to facilitate testing.

Earthingof Switchboards/Panels

Eachswitchboard,controlpanel,etc.shallbeprovidedwithanearthbusbarrunningalongitsentire length. The earth bus bar shall be located at the bottom of the board / panel.

Earthbus bars shall be of copper and shall be rated tocarrythe rated symmetrical short circuit current of the associated board / panel for one second, unless otherwise specified. Earth bus bars shall be properlysupportedtowithstandstressesinducedbythemomentaryshortcircuitcurrent ofvalueequal to the momentary short circuit rating of the associated switchboard / panel.

Positiveconnectionoftheframesofalltheequipmentmountedintheswitchboardtothe earthbusbar shall be maintained through insulated conductors of size equal to the earth bus bar or the load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to earth bus bar by means of 1100V grade, green coloured,PVCinsulated,stranded,tinnedcopper,2.5sq.mmconductorloopedthroughthecaseearth terminals.

InternalWiring

The internal wiring shall be carried out with 650 / 1100V grade, PVC insulated, stranded conductor wires.Theminimumsizeofconductorforpowercircuitsshallbe4Sq.mmcopperconductor. Control circuits shall be wired with copper conductor of at least 1.5

Sq.mm.

I/OforInstrumentation,Control&AutomationSystemfromElectricalpanels.

I/O signals from instruments shall be wired to marshalling box of MCC / Switch gear such that instrumentationengineersshallnotenterintopowersystempanelthatarenotfamiliar withthem. Necessary provisions shall be incorporated to meet the requirements indicated in:

(a) I/O Schedules – ACB / VCB, Command Open & Close, Feedback trip, Breaker healthy(Ready to close), Local / Off / Remote, Breaker Opened / Closed, Beaker Test / Service position feedback.
(b) DataTransfer Schedule.
(c) Alarm Schedule of Particular requirement of Instrumentation, Control & Automation System, Part - 13, and Volume 2 of the Bid document.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedlitera ture,catalogues, type test certificates of typical transformer etc. shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

PowercapacitorandAPFCcontrolpanel(415V)

ApplicableStandards

The capacitor and control panel conform to the latest applicable standards specified below. In case of conflict between standards and this specification, this specification shall govern.

Shuntcapacitorsforpowersystems	IS:13585,IS: 13340
Internalfusesandinternaloverpressuredisconnections forshunt capacitors - Specification	IS: 12672
Metalenclosedswitchgear	IS/IEC60947/ BSEN60298/ IEC:60298
Codeofpracticeforphosphatecoatedironandsteel	IS:6005/BS: 3189
Specificationforcopperrodsandbarsforelectrical purpose	IS:613

DesignFeatures

(a) The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not.

(b) The capacitor bank shall be complete with the required capacitors along with the supportingpost insulators, steel rack assembly, copper bus bars, copper connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.

(c) The capacitor bank may comprise of suitable number of single-phase units in series parallel combination. However, thenumber of parallel units ineach ofthe seriesracks shall be suchthat failure of one unit shall not create an overvoltage on the units in parallel with it, which shall result in the failure of the parallel units.

(d) The complete capacitor banks with its accessories shall be metal enclosed (in sheet steel cubicle), indoor floor mounting and free-standing type.

(e) Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidecovers.

(f) All sheet steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate coated and then painted with two coats of zinc rich primer paint. After application of primer, two coats of finishing synthetic enamel paint oven baked / stove shall be applied.

(g) The assembly of the banks shall be such that it provides sufficient ventilation for each unit. Necessary exhaust fan, louvers with filters must be provided in the cubicle to ensure proper ventilation for heat dissipation.

(h) Each panel shall be provided with 240 Volts, 1 phase, 50Hz, 5amps, 3pin receptacles with switch located in a convenient position. An interior illuminating CFL / LED lamp together with the operating door switch and protective fuses shall be provided.

(i) Each capacitor unit / bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute in accordance with the provisions of the latest edition of IS: 2834.

(j) Capacitors shall be of Mixed Dielectric of polypropylene and paper with internal element fuses. The impregnate shall be non-PCB (poly chlorinated biphenyl) oil.

(k) Each unit shall satisfactorily operate at 135% of rated KVAR including factors of overvoltage, harmonic currents and manufacturing tolerance. The units shall be capable of continuously withstanding satisfactorily any overvoltage up to a maximum of 10% above the rated voltage, excluding transients.

(l) Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute upon disconnection, in accordance with the provisions of the latest edition of IS:2834.

(m) APFCR panel shall have suitable detuned reactors for harmonic filtration in case of PMCC connected with VFD or Soft Starters.

(n) ThePFCsystemshall beprovidedtoachieveapowerfactorofnotlessthan0.98.

(o) UnitProtection

Each capacitor unit shall be individually protected by an HRC fuse suitably rated for load current and interrupting capacity, so that a faulty capacitor unit shall be disconnected by thefusewithout causingthe bankto be disconnected.Thus, the fuseshall disconnect onlythefaulty unit and shall leave the rest of the units undisturbed. An operated fuse shall give visual

indication so that it may be detected during periodic inspection. The fuse braking time shall co- ordinate with the pressure built up within the unit to avoid explosion. Mounting of theindividual fuse may be internal or external to the capacitor case.

TheInputstotheAPFCsystemisVoltageinputfromtwophasesandcurrent input fromthethird phase. Out of two phases of voltage one phase voltage is taken as Reference 0and another phase

voltage as 440V. APFC need to be installed CT (Current Transformer) on the third phase at main incomer ACB aftertransformer, which shall give signal tothe APFCRelay. Basedon theseinputsthe ASIC (Application Specific Integrated Circuit) OR call it as Microprocessor internal to the APFC Relay shall give output signal to relay outputs which shall energize coil of the contactor so that the contactorcomeinlineconnectingthecapacitorbankincircuit.However, thisisstepcorrectionmeans PF shall be corrected in steps. The Voltage rise due to connection of capacitor banks is marginal.
ThereshallbenofrequencycorrectionwithAPFCSystemandAPFCRelayshallhavecommunication port (RS 485).

PowerCapacitorandControlPanel

(a) Power capacitor and control panel shall be housed in metal enclosed cubicle. Power capacitor shall be housed in the lower compartment and capacitor control panel at top compartment.
(b) The control equipment including capacitors shall be mounted in a panel of cold rolled sheet steel. The panel shall be of indoor type and shall consist of:

- Busbars shall be of copper conductor of hard drawn (HD) and high conductivity. All bus shallbe insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi.
- Isolatingswitch.
- Contactorwithoverloadelement.
- APFC Relays responsive to current / voltage / kVAR / PF as specified for automatic switching shall be of microprocessor based suitable for both for state board Electricity and DG set with reduced power factor.
- Sequencing devices, timers and auxiliary relays for automatic sequential switching of the capacitors in and out of the circuit.
- Auto-manualselectorswitches.
- Pushbuttonforopeningandclosingthepower circuit.
- RedandgreenclusterLEDlightsforcapacitorsON/OFFindication.
- Protective numerical relays to protect the healthy capacitor units when one unit fails in a series connection.
- Spaceheaterandcubiclelightingasperthe requirements.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

SoftStarters

ApplicableStandards

Thedesign,manufactureandperformanceofequipmentshallconformtothelateststandardsspecified below.

SwitchgearGeneralRequirements	IS:13947/BS:5486/ IEC:60947
Factory Built Assemblies of SWGR and ControlgearforVoltagesuptoandincluding 1000V AC & 1200V DC	IS:8623/BS:5486/ IEC:60439
AirBreakSwitches	IS:13947-P3/BSEN60947/ IEC:60947-3
MouldedCaseCircuit Breaker	IS2516/IEC60947-2/BSEN60947-2
MiniatureCircuitBreakers	IS:8828/ BSEN:60898
Lowvoltage Fuses	IS:13703/BS:1362/IEC:60269-1
Contactors	IS:13947/BSEN60947-4/IEC:60947-1
Starters	IS:13947/BSEN60947-4/ IEC:60292-1to 4
ControlSwitches/Pushbuttons	IS:6875/ BSEN60947
CurrentTransformers	IS:2705/ BS:7626
VoltageTransformers	IS:3156/BS:7625/IEC:60044, 60186
Indicatinginstruments	IS:1248/BS:89/ IEC:60051
MarkingandIdentificationofConductors and Apparatus Terminals	IS:11353/ BS:159
A.C.ElectricityMeters	IS:722,8530/BS:5685/ IEC60145,60211
Degreeof Protection	IS:13947/IEC:60947-P1
Selectioninstallationandmaintenanceof switchgear and control gear	IS:10118
Codeofpracticeforphosphatingcoatediron and steel	IS:6005/ BS:3189
Specificationforcopperrodsandbarsfor electrical purposes	IS:613
Control transformers for switchgear and controlgearvoltagenotexceeding1000V AC	IS:12021
ClassificationofHazardousareashaving	IS:5572

FlammablegasesandvapoursforElectrical Installation	
GuideforSelectionofElectricalEquipment for Hazardous areas	IS:5571
Electricalapparatusforexplosivegas atmospheres-General Requirements	IEC:60079

ConstructionalandPerformanceFeatures

(a) The Soft start panel shall be indoor, metal clad, floor standing, compartmentalised completewith reactors, busbars, vacuum contactor, control, metering, protection equipment andindicating lamps, etc.
(b) Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidecovers.
(c) The Soft starter shall achieve smooth starting by torque control for gradual acceleration of the drive system thus preventing jerks and extending the life of equipment.
(d) Protectionshallbeprovidedforsoftstarters(semiconductorfuse).
(e) Startingcurrentshallbelimitedto3.0timesthefullloadcurrentofthemotor.
(f) TheSoftstartershallhavepossibilityforlowspeedforwardandbackwardoperation for positioning of a motor.
(g) TheSoftstartershallhavebuilt-indiagnostics,faultdetectionandfault history.
(h) The Soft starter shall integrate motor and load protections, which shall under no circumstances be disabled when the integrated bypass shall be used.Thefollowing motor protections available along with warning function:
i) Electronicoverloadprotection.
ii) Lockedrotor protection.
iii) Motorunderloadprotection.
iv) Currentimbalanceprotection.
v) Voltageimbalanceprotection.
vi) Overvoltage&undervoltageprotection.
vii) Phasereversal protection.
viii) Totalharmonicdistortion(THD).
ix) Fans fault.
x) Thyristoroverload.
xi) Numberof starts.
xii) Motorruntimelimit.
(i) TheSoftstartershallmakeitpossibletorunthemotorinaweakernetworkandhenceimproving the availability of the system / equipment with following types.
i) Current.
ii) Dualcurrentlimit.
iii) Currentramp.
(j) Separateremovable glandplatesshall be providedforpower and controlcables.Thegland plate for the power cables shall be of non-magnetic material.
(k) Allsheetsteelworkshallbethoroughlycleanedofrust,scale,oil,grease,dirtandswarfby pickling, emulsion cleaning etc. The sheet steel shall be phosphate coated and then painted with

two coats of zinc rich primer plant. After application of the primer, two coats of finishing synthetic enamel paint oven baked / stoved, shall be applied.

(l) The cable alley shall house all power cable connections along with associated cableterminations.

(m) Each cubicle shall be fitted with a label in the front and rear of the cubicle, indicating the panel designation, rating and duty. Each relay, instrument, switch, fuse and other devices shall be provided with separate labels.

(n) Caution name plate with inscription “Caution - Live Terminals” shall be provided at all points where the terminals are likely to remain live and isolation shall be possible only at remote end, e.g., incoming terminals of main disconnecting switch.

(o) Starting of motor shall be from either Soft Starter panel located near to motor or shall be from MCC Panel or from PLC. Necessary wiring diagram shall be provided considering starting interlock, trip circuit, starting and running mode signal.

(p) The soft starter panel shall have soft start and soft stop facility during normal operation.
Thyristorfusesshallhaveatripindicatortooperateasuitablemicroswitchwithleast1NO+1 NC potential free contacts for annunciation and / or tripping.

(q) Thesoftstarter panel shallbe installedinAir Condition room, it shallnotclub with PCC/MCC panels.
The soft starter panel shall be provided with sufficient ventilation for each unit. Necessary exhaustfan,louverswithfiltersmustbeprovidedinthecubicletoensureproperventilation

Main Busbars

(a) Busbars shall be supported on insulators capable of withstanding dynamic stresses due to short circuit.

(b) Busbars shall be of copper conductor of hand drawn (HD) and high conductivity. All busbars shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi.

(c) The temperature rise of bus bars shall be limited to 40 degree centigrade over 45-degree centigrade ambient temperature.

(d) All sheet steel work shall be phosphate coated in accordance with the following procedure andinaccordancewithIS:6005“CodeofPracticeforPhosphatecoatedIronandSteel”.Oil,grease, dirt and swarf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphate coated, thorough rinsing shall be clean water followed by final rinsing with dilute dichromate solution and even drying. The phosphate coating

shall be followed by the application of two coats of readymixed stovingtype zinc chromate primer.Thefirst coat maybe “flash dried” while thesecondcoatshallbestoved.Afterapplicationofthetwocoatsofprimerfinishingsynt heticenamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests.

The final finished thickness of paint film on steel shall not be less than 80 microns and shall not be more than 120 microns. Finished painted surface of panels shall present an aesthetically pleasing appearancefreefromdentsandunevensurface.Asmallquantityoffinishingpaintshall besupplied for minor touching up required at site after the installation of the panels.

Earthing

(a) An earthing bus shall be provided at the bottom and extended throughout the length of thepanel. It shall be bolted / welded to the framework.
(b) All non-current carrying metal work of the panel shall be effectively bonded to the earth bus. Hinged doors shall be earthed through flexible earthing braid.

PanelAccessoriesandWiring

(a) Panel shall be supplied completely wired internally up to equipment and terminal blocks and ready for the external cable connections at the terminal blocks. Inter panel wiring between compartment of the same panel shall be provided.
(b) All auxiliary wiring shall be carried out with 1100 volts grade, single core, stranded copper conductor with PVC insulation. The sizes of wire shall be not less than 1.5sq.mm.
(c) Terminal blocks shall be of stud type, 1100 volts grade 10 amps rated, complete with insulated barriers. Terminal blocks for CTs shall be provided with test links and isolating facilities.
(d) All spare contacts and terminals of cubicle mounted equipment and devices shall be wired to terminal blocks.
(e) Accuracy class for indicating instruments (MFM with communication port-RS485) shall be 1.0. Instruments shall be 110 / 96 mm square, 240˚ scale for flush mounting with only flanges projecting.
(f) Relaysshallbesuitableforflushmountingwithonlyflanges projecting.
(g) Pushbuttonsshallbeprovidedwithinscriptionplatesengravedwiththeirfunctions.
(h) IndicatinglampsshallbeofLEDtype.
(i) Space heaters of adequate capacity shall be provided inside each panel. They shall be suitable for 240V, single phase, 50Hz supply. They shall be complete with MCBs, isolating switchesand thermostat.
(j) Each panel shall be provided with 240 Volts, 1 phase, 50Hz, 5amps, 3pin receptacles with switch located in a convenient position. An interior illuminating CFL / LED lamp together with the operating door switch and protective fuses shall be provided.
(k) Provision shall be made for receiving, distribution, isolating and fusing of auxiliary supplies for controls, space heating etc. The fuse ratings shall be so chosen as to ensure selective clearanceof sub-circuit faults.
(l) FusesshallbeHRCcartridgetype mountedonplugintypefuse base.
(m) The auxiliary supply shall be distributed inside the panel with necessary isolating arrangements at the point of entry and with sub-circuit fuses as

required.

CableTermination

(a) Necessary number of cable glands shall be supplied for terminating auxiliary power and control cables. Glands shall be of heavy-duty brass castings, machine finished and complete with check nut, washers, neoprene compression ring etc.
(b) Cable lugs for all power and control cable connections shall be supplied. The lugs shall betinned copper / aluminium depending on cable conductor and of solderless crimping type.
(c) All necessary materials required for terminating the power cables such as tapes, fillers, binding wires, armour clamps, brass glands etc. shall be supplied.

DrawingsandData

AllDrawings,data,technical,particulars,temperaturerisecalculations,detailedliterature,catalogues, test certificates etc., shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

DieselStandby Generator

ApplicableStandards

TheDieselStandbyGenerator(asperlatestCPCBIV/ KSPCBnorms)anditscomponentsshall conform to the latest applicablestandards specified below:

DieselEnginesforGeneralPurposes	:	BS5514/ISO3046
TheElectricalPerformanceofRotatingElectrical Machinery	:	BS5000
RotatingElectricalMachines	:	IS15999-1
Circuitbreakers	:	IS-13118,BS-5311,IEC-56& 694, BSEN-60942 (P-2)
Airbreakswitches	:	IS/IEC60947-3,IEC60947-3
Currenttransformer	:	IS 16227 (Part 2) : 2016/IEC 61869-2:2012/BS-7626,IEC-60185
Potential(Voltage)transformer	:	IEC60189
ElectricalRelays	:	IS/IEC-60255,IEC-60255
Contactors/Starters	:	IS/IEC60947-4,IEC60947-4
ControlSwitches/PushButtons	:	IS/IEC60947-5-1,IEC60947-

		5-1

HighVoltage Fuse	:	IS9385(Part1):2018 IEC60282-1:2009
LowVoltageFuse	:	IS/IEC60269-1:2014
IndicatingInstruments	:	IS-1248/IEC-60051
A.C.electricitymeters	:	IS11448/IEC62053
Resistancewire,tapesandstripesforheatingelements	:	IS-3725
Wroughtaluminumandaluminumalloybars,rods,tubes and sections for electrical purposes	:	IS-5082/IEC60114
Specificationforcopperrodsandbarsforelectrical purposes	:	IS-613
Toggleswitches	:	IS-3452/BS-3676
Controlswitches/pushbuttons	:	IS13947:Part5:Sec1/BSEN 60947
NoiseandEmissionLimit	:	As per latest notification of ministryofEnvironmenta nd Forests

GeneralRequirements

Thediesel engineand generator shall beskid mountedand shall belocated ina roomnear treatment plant substation building. The diesel engine shall draw cooling air directly from outside the room throughaweatherproof,acousticallytreatedduct.Theexhaustsystemshallbeinsulatedtominimize the amount of heat entering the room and to prevent injury to personnel.

The exhaust system pipe shall be required height above the nearest building as per latest CPCB guideline. The exhaust pipeline diameter shall be suitably designed to avoid back pressure when dischargedathigherelevation.Thesilencershallbeofthe‘residential’typeandbelocatedexternally.

The generation voltage shall be 415V for D.G capacity less than 2 MVA and 11kV for D.G capacity morethan2MVA.IfmorethanoneD.Gsetshallberequiredforachievingtherequiredloadcapacity, they shall be operated in parallel with necessary synchronizing arrangement with LCD. At no point D.Gsetsshallbeoperatingparallelwith grid.

Tank

Thetankshall beprovidedwithfittingstopermitthevisual observationoffuel level andtoenable fillingbylocaltankeroperators.Alevelsensor/switchesshallalsobemountedinthetanksothat

remainingfuelvolumecanbemonitoredatthegenerator/ substationPLCandtheoperatorstationsin the SCADA room.

Fuelsystem

The fuel System shall comprise an engine driven feed pump with duplex filters, high level 990 litres day tank located in the generator room or generator skid mounted day fuel tank with supporting structureor generator skidmounted dayfuel tank, with all interconnectingpipe work, flexible engine connectionpipeetc.Asemi-rotaryhandpumpshallbeprovidedtopermittransferoffuelintheevent of a failure of the transfer pump. Any leakage from the pumps shall be routed to the bund.

Afirealarmsystemshallbeprovidedwithinthegeneratorroomtodetectfire,toraisealocal audible alarm (manually silenced locally).

AllalarmsshallbeconveyedtothecentralSCADAthroughthePLC.

DieselGeneratingSetAutomaticControl

AMFDieselGeneratorSetcapable ofautomaticstartingandpickingtheloadwithin30secondsshall be provided to cater for emergency loads, lighting loads and other identified critical loads during mains power failure. Diesel generating set for use in auto mains failure mode shall have a three- position automatic / off / manual selection and shall operate as follows:

(i) <u>Automaticmode:</u>
Onoccurrenceofmainsfailure,thefollowingsequenceshallbefollowed.

(a) MainstoGeneratorchangeover.
- mainsfailuredetected.
- delayof10 seconds.
- generatorshallbestartedandrunuptospeed.
- timedelayof50seconds.
- mainssupplyshallbeswitchedoff.
- generatorsupplyshallbeswitchedon.

(b)GeneratortoMainschangeover.
- mainsrestoredandhealthydetected.
- manualchangeoversignalreceived.
- generatorsupplyshallbeswitchedoff.
- mainssupplyshallbeswitchedon.
- generatorrunsfor2minutesand stops.

Alltimersettingsshallbeadjustable.

If mainspowershallberestoredduringtheinitialone-minutedelaythenthepowershallbemonitored for a further one minute and if it shall be still healthy, mains power shall be restored. The generator shall be stopped after a further 2 minutes of running on no load. If the generator fails to

start after an initial period of cranking, two further attempts shall be made with an appropriate interval between

eachattempt.Iftheenginefailstostartafterthreeattemptsthesystemshallshutdowna ndalocaland remote alarm shall be annunciated.

(ii) Manualmode:
Thegeneratorshallruntothedictatesofmanual controlsonthegenerator.Noautomaticchangeover of mains to generator supply or vice versa shall take place. The generator shall be loaded by manual switching if required.

AlternatorforDieselGeneratingSet

Thegenerationvoltageshallbe415Vforcapacitylessthan2MVAand11kVforcapacity 2MVAand above.

Alternatorshall be4pole,3phase,50Hz,0.8P.F,salient pole,revolvingfield,Brushlesstype,self- regulating continuously rated and manufactured in accordance with IS 15999-1, BS 5000: Part 99 or IEC 60034-1. They shall be totally enclosed, screen protected, fan ventilated and vertical drip-proof conforming to IP 23.

The Alternator shall be complete with excitation system, AVR and all necessary auxiliaries. The alternator shall bedriven bydieselengine detailed below and shall match the same in all respects.The terminal box shall be dustproof with IP 54 degree of protection. The terminal box shall be suitably sizedtoterminatethesizeandnumberofcablesinvolved.Alternatorsshallbe capableofwithstanding a 10% overload for 1 hour in any 12 hours Period under the specified conditions of temperature, humidity and atmospheric pressure.

Alternator windings shall be of Class H insulation with Class F temperature rise and tropicalised. The alternator shall have pre-packed grease lubricated ball or roller bearings and provided with facilities fordegreasingwhilstinservice.Thealternatorshallbefootmountedonacommonbedfr amewiththe prime mover close coupled to the engine flywheel housing. The direction of alternator rotation when viewed from the driven end shall be clockwise and phase voltage sequence UVW. The alternator vibration level shall not exceed the values defined in IS 12075/ IEC 60034-14. The alternator shall be capable of maintaining a short circuit current of three times full load current for a period of 10seconds.

The alternator shall be fitted with an anti-condensation Alternator shall have 6 nos. duplex RTDs insidethestatorwinding.Noindividualharmonicshallexceed1%andthetotalharmon icshallnot exceed 3%.The alternator,it’s neutralandcontrol panel shall beearthed asper relevant standards. Alternator rotor assembly shall comprise exciter rotor, full wave silicon bridge rectifier, surge protection device and salient pole rotating field system.

Therotorshallbefittedwithinterconnectedpolefacedampingwindings.Voltageregul ationshallbe maintained to within ± 2.5% for a power factor of 0.8 to unity,

including hot to cold variations. The steady state frequency droop between no load and full load shall not exceed 5%. Transient voltage deviation following a step load of 60% of rated at a power factor of between 0.4 and zero shall not exceed 15% with a voltage recovery time to 97% rated voltage not exceeding 0.5second.

The set shall be capable of continuous operation with a phase current imbalance of 33% of rated current whilst maintaining the output voltage within ± 5% of rated. Alternator shall have sensors for alternatorprotectionandshallbewiredtocontrolpanel.Thealternatorshall beprovidedwithclassF insulation with temperature rise limited to that of class B insulation.

DieselEngineforGeneratingSet

Engineshallbefour-stroke,directinjection,andturbochargedindustrialmachines.Theyshallbefitted with renewable wet cylinder liners if water cooled and shall be direct coupled to the alternator and mounted on a common rigid steel bedplate. Engines shall be rated for continuous duty at site ambient conditions with an inherent O/L Capacity of 10% for 1 hour in any 12 hours. The engine shall be capable of running at full load for not less than 180 hours without maintenance adjustments and10,000 hours between major overhauls. The maximum operating speed shall be 1500 rpm. The range of manual adjustment shall not be less than ±5% of rated speed.The performance of engine governors under load conditions shall be to Class A2 in accordance with BS 5514: Part 4.

Enginegovernorsshallbesuitableforremotecontrolloadsharingbetweenidenticalengineunits.In addition toanyelectricalover speedtrips,thereshall bea mechanical overspeed device which shall operate at 120% of the rated speed. Re-setting of the over speed trip shall be possible by hand only. Thesteadystateoutputspeed drop between no load and fullloadshall not exceed5%.Thetransient output speed deviation shall not exceed 10% for a step of 60%.

Engines shall be designed to run on fuel oil complying with IS 1460 or BS 2869, Class A2. Engines shall be cooled by means of a water jacket, heavy duty air blast radiator with integral radiator header tank,circulatingpumpandenginedrivenpushertypefan.Thefanshall drawairinfromthevicinityof the engine block and discharge it through the radiator core. The radiator shall be mounted onthe same bedplate as the engine and alternator on suitable vibration isolators and be arranged so that it shall be located directly behind automatic louvers set into the external wall of the engine room. A thermostatically operated by-pass valve shall be fitted in the cooling system to maintain an optimum operatingtemperature duringstartingand runningconditions. Drain cocks shall be provided so that all the water can be drained from the system. A separate oil cooler shall be used for cooling the engineoil. A thermostatic by-pass valve shall be incorporated.

Engine lubrication shall be by a closed-circuit wet sump, forced feed system supplied by an engine driven pump fitted with pressure regulating and relief valves, sump suction filter and changeover renewable micro-felt full flowline filters. A hand operatedsemi-rotaryoil pump shall beinstalled to carry out initial priming or to fill or empty the sump as required. The sump shall be fitted with an easilyaccessibledrainpoint.Theoilshallbeofthegraderecommendedbytheenginem

anufacturer.

The starting system shall comprise 12 or 24V heavy duty lead acid batteries (positioned on a floor mountedstandadjacenttotheengine)connectedbyheavydutyflexiblebutylrubber cables.Batteries shall be sized to give six consecutive starts of the engine at 0˚C. An engine driven alternator and charging system shall be provided. An automatic main energized battery charger shall be provided, with sufficient capacity to maintain the battery in a condition to full fill the starting requirements.

Barring(handturning)equipmentshallbeprovidedsothattheenginecanbemanua llyrotatedfor maintenance purposes. It shall be arranged sothat normal startingof the engine shall be inhibited whilst the hand turning equipment shall be connected.

Twinheavy-dutyairintakefiltersinaccordancewithIS3169orBS7226suitableforoperatingindust ladenatmospheresshallbefitted.Thefiltersshallbeofthepaperelement withpre-cleanertype.Turbo charger filters shall be fitted. Breathers shall be fitted with washable filters which are easily accessible for maintenance.

Instrumentation shall be provided to monitor speed, oil pressure, oil temperature (sets larger than 250kVA), water temperature and battery charge current. The bedplate shall be of heavy gauge steel construction,stressrelievedandfreefromdistortion.Engineshallbeprovidedwithsen sorsforengine protection and shall be wired to control panel.

Machinedsurfacesshallbeincorporatedformountingsandforlevelling.Anti-vibrationmountings shall be fitted between the bedplate and the floor to prevent vibrations being transmitted to the building. The mountings shall be adjustable for levelling purpose and shall be designed to resist horizontal movement of the diesel set.

The fuel system shall comprise an engine driven feed pump with duplex filters, 990 litres day tank withsupportingstructuresorgeneratorskidmounteddayfueltankwithallinterconne ctingpipework, flexible engine connection pipe etc.

DieselGeneratorControlPanel:

The control panel shall haveprovisionsuchthatinter-operabilitywithinstrumentationcontrol system. The control panel with communication facility shall be separately mounted on anti-vibration mountings and shall comprise the following:

- Breakerincorporatingshortcircuitandoverloadtrip.
- Earthfaultprotectionforthe Alternator.
- AlternatorOver&UnderVoltageProtection.
- VoltageControlledOverCurrentRelay.
- Voltmeterwithbuiltinselectorswitch/(digital)
- ammeterwithbuiltinselectorswitch/(digital)
- frequencymeter
- PowerFactorMeter
- KWhMeter(Multifunctionmeter)
- Enginetemperatureandoilpressuregauge
- servicehoursrun indicator
- keyswitchstartsandstop control
- operationalstatusindicator
- anti-condensationheaterandthermostat
- alternatoranti-condensationheatercontrols

- mainsfedbatterycharger
- Autostartonmainspowersupplyfailurefacility

- FailstoStart(Alarm)
- Over/UnderVoltage(Alarm)
- BatteryChargerFault (Alarm)
- LowfuelOilLevel (Alarm)
- Overload(Alarm)
- LowLubeOilPressure(Trip)
- HighWaterTemperature(Trip)
- HighLubeOilTemperature(Trip)
- ElectricalProtectionRelays(Trip).

Aresetbuttonshallbeprovidedtocancelthealarm/shut-downconditionpriortore-starting.

Simple operating instructions shall be detailed on the fascia of the control panel. All alarm and trip statussignalsfromdieselsupplysystem,enginecontrolpanelandalternatorprotectio nshallbehard wired to a marshalling box for instrumentation control system.

Busbars shall be of copperconductorof hand drawn(HD) and high conductivity. All bus bars shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of highdielectricstrength,toprovideapermanentnon-ageingandnon-trackingprotection,imperviousto water, tropical conditions and fungi.

SynchronisingPanel

Whenevertwoormoresetsarerequiredtooperatetogether,necessarysynchronizingp anelcomplete with circuit breaker, synchro scope, numeric relays, digital meters etc shall be provided. The Panel shall be floor standing, CRCA Sheet steel enclosed.

AcousticEnclosure

(i) TheDGSetshallbeprovidedwithacousticenclosure,fullyintegrated,weatherpr oofwith superior finish for long and durable life.

(ii) TheacousticenclosureshallbeCRCAsheetsteelenclosedwithnecessarypanelsa nddoors, inside lining of fire-retardant foam / glass wool as acoustic material.

(iii) Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandside covers.

(iv) The sound level shall be restricted to 75dB at a distance of 1 meter, under full load, free fieldconditions as per relevant standards.

(v) Theacousticenclosureshallbecertifiedtomeettheemissionnorms.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedlitera ture,catalogues, type test certificates of typical transformer etc shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid

Documents.

UPS,Battery,Battery ChargerandD.CDistributionBoard

UPSshallbesuppliedasperInstrumentationspecification.UPS,Battery,BatteryChargershallbe three phaseincomingsupplywith breaker. DC equipment shall complywith IEC60896 including those standards referred to therein.

GeneralRequirements

Followingitemsshallbecoveredinthe Contract:

- One no. 110V Nickel Cadmiumtype Battery Bank (sized as per requirements mentioned in Part 12).
- Oneno.Float-cum-boostchargerfor110Vbatteries.
- DCdistributionboard.

Allconnectionsbetweenbattery,batterychargersandDCdistributionboardshall bedesignedfor effective segregation between positive and negative leads.

BatteryRoomLayout Requirements:

- Batterycellsshallbeinstalledinseparateroompreferablynear theDCloads.
- Light fixtures in the battery room shall be flameproof and shall preferably mounted on walls, or if installed on ceiling shall not mounted directly above the battery banks. Switch controls for lights and exhaust fans shall be installed outside the battery room.
- False ceiling & false flooring shall be avoided in the battery room. Ducts or other systems shall not be run through battery room.
- 2 Nos.flameproofexhaust fansshall beprovidedtoexhaust gasesandsmoke frombatteryroom (in case of fire from battery room).
- Battery room upto 2 mtrs height shall be provided with acid proof tiles. Wall above 2 mtrs and roof beams shall be painted with Alkali resistant protective coating.
- Washbasinwitheyewashershowershallbeprovidedinbatteryroom.
- A warning sign board should be displayed at the entrance and inside to the battery rooms inview of presence of Hydrogen gas. Hydrogen gas detector shall be installed based on vendor recommendations.

Nickel-CadmiumBattery

DesignFeatures

(a) Battery offered shall be Nickel Cadmium (Ni-Cd), Sintered Type. The battery shall conform to the latest applicable standards specified below:

Specificationforsinteredtype:IS1091NickelCadmiumSinteredBatteries

(b) Nickel hydroxide and Cadmium hydroxide shall be used for positive and negative electrode respectively. Aqueous solution of battery grade Potassium hydroxide with small quantities of lithiumhydroxide shall be used as electrolyte. It shall be used only for ion transfer and shall not chemically change during charging / discharging.

(c) The containers shall be transparent and preferably be made of toughened glass or plastic polypropylene material and provided with electrolyte level indicator. The Containers shall be robust, heat resistant, leak proof, non-absorbent and free from crack, blisters, pin hole etc.

(d) Thebatteryshall beratedon5-hourbasisandforthespecifiedambienttemperature.Thebattery shall have maximum recharge time of 8 hours.

(e) Terminal posts shall be designed to accommodate external bolted connection conveniently and positively. Eachterminal post shall have two bolt holes of the same diameter, preferablyatright angles to each other. The bottom hole shall be used to terminate the inter-cell connection. The top hole shall be left for external terminal connections. Bolts, heads and nuts, except seal nuts, shall be hexagonal and shall be lead covered. The junction between terminal posts and coverand between cover and container shall be so sealed as to prevent any seepage of electrolyte.

(f) Required quantity of electrolyte for first filling with 10% extra shall be supplied in non- returnable containers.

(g) Each battery shall be complete with following accessories, as applicable, that include, but arenot limited to:

(i) Batteryracks.

(ii) Porcelaininsulators,rubberpads,etc.

(iii) Setofinter-cell,inter-tierandinter-banknickelcoatedcopperconnectorsas required for the complete installation.

(iv) Electrolyteforfirstfilling+10%extra.

1setofaccessoriesfortestingandmaintenanceshall alsobeprovidedsuitableforallthethreebattery banks.

i.	One	-	-3,0,+3voltsDCvoltmeterwithbuilt-indischarging resistorand suitable leads for measuringcell voltage.
ii.	One	-	Fillerholefloatfittedwithplugandcapandhaving specific gravity correction scale.
iii.	Three	-	DigitalportablePocketthermometers.
iv	Two	-	Cellliftingstraps.
v	Onesetof Each	-	Terminalsandcableboxeswithglandsforconnecting cable as required. Spare connectors. Spare vent plugs.

Sparenutsandbolt

s.

Suitablesetof spanners.

(h) Each battery shall be mounted in a manner that permits easy accessibility to any cell. The racks shall be suitable for fixing on flat concrete floor. The complete racks shall be suitable for bolting end to end.

(i) It shall be the responsibility of the contractor to provide batteries of adequate capacities to meet specified requirements pertaining to control, indication, annunciation, etc. and emergency lighting. For computing battery capacity, it shall be assumed that the battery is fully charged at the beginning of loading cycle and is discharged to a voltage of 1.2 volts per cell at the end of the loading cycle. The battery shall have minimal difference (approx. 0.3 V per cell) between float and boost charging voltages.

(j) Thefollowinginformationshallbelegiblymarkedonoutsideeachcell.

- Manufacturer'sName&Trademark.
- Country&YearofManufacture.
- AHCapacityat5-hourdischarge rate.
- TypeDesignation&Sl.No.

Drawing

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc shall be submitted along with the bid / after award of contract as specified under "Bid / Contract Drawings", Part 3, General Requirements, Volume - 2 of Bid Documents.

BatteryChargerandD.C.DistributionBoard

ApplicableStandards

The battery charger and D.C. distribution board shall conform to the latest applicable standards specifiedbelow.IncaseofconflictbetweenthestandardsandthisSpecification,thisSpecification shall govern.

Basic climatic and mechanical durability : IS/IEC60068 tests for components for electronic and electricalequipment

Environmental tests for electronic and :

IS/IEC60068

Electrical equipment

Metalcladbasematerialforprinted circuitsforuseinelectronicand telecommunicationequipment	:	IS:5921
Transformersandinductors(power, audio,pulseandswitching)for electronicequipment	:	IS:6297
Printedwiringboards	:	IS:7405
Environmentalrequirementsforsemi-Conductordevicesandintegratedcircuits	:	IS6553
Terminalsforelectronicequipment	:	IS:4007
Factorybuiltassembliesofswitchgearand controlgearforvoltagesuptoand including 1000V AC and 1200V DC : IEC:60439		IS:8623/BS: 5486/
Airbreakswitches BSEN60947-3	:	IS:13947(Part - 3)
Miniaturecircuitbreakers BSEN:60898	:	IS8828/
HRCcartridge fuses	:	IS:9224/BS:88
Contactors	:	IS:13947(Part-3)/
BS:775 / IEC:60158-1		
Controlswitches/pushbuttons	:	IS:6875
Indicatinginstruments EC:51	:	IS:1248/BC:89/
Degreeof Protection IEC:60947-1	:	IS:13947-(Part1)/
Climate-proofingofelectricalequipment	:	BSCP:1014
Code of practice for phosphate coated iron and Steel	:	IS:6005/BS:3189

Semi-conductorconverters	:	IEC:60146
Semi-conductor rectifier equipment safety code	:	IS:6619
Specification for copper rods and bars for electrical purposes	:	IS:613

Batterycharger

(a) Batterychargershallbecombinedfloat-cum-boosttype.
(b) The charger shall be static type composed of silicon-controlled rectifiers (SCRs) and diodes connected in three phase full wave half-controlled bridge circuit.
(c) The rectifier transformers for float and boost chargers shall be indoor dry type, double wound with delta-star connections. The BIDDER shall ascertain if taps are required and provide adequate number of primary and secondary taps, if necessary.
(d) Thefloatchargershallbedesignedforsupplying:
(i) TheD.Ccontinuousloadandshort-time overload.
(ii) Thetricklechargingcurrentofthebattery.
(e) Theboostchargershallbedesignedforsupplyingtheboostchargingcurrentofthe battery.
(f) If the battery and charger are to be supplied by separate contractors, the charger contractor shall coordinate withthe batterycontractor regardingfloat / trickle boost chargingcurrent & voltages required for the battery.
(g) Battery Charger shall be provided with facility for both automatic and manual control of output voltage and current and necessary selector switch shall be provided. contractor regarding the float / trickle and boost charging current and voltages required by the battery.
(h) Performance
(i) FloatCharger

TheD.C.outputvoltageduringfloatchargingshallbestabilizedwithin ±1%ofthesetDCbus voltage. Manual control shall be used if auto mode fails.

(ii) Boost Charger

Forboostchargingthedischargedbatteryafteramainsfailure,therectifiershallcharg ethebatteryat high rate limited to the maximum boost charging voltage. After a specified number of hours (adjustable) when the rated cell voltage shall be reached, the charger shall be returned to float charge status.

- In case of combined float cum boost charger, the switching and control of high-rate charge and returntofloat chargeshallbebyautomaticcontroller/regulator.Manual controlshall beusedif

auto-mode fails.

- Duringboostchargingfollowingemergencymeasuresshallbeprovided:
- If the AC mains supply fails, an arrangement shall be made to automatically connect the battery directly across the load.
- If the separate or spare float charger supplying D.C. load fails, the load shall be fed from the point of connection at the tapping of the battery via adequately rated blocking diodes.

(iii) Suitablefilter Circuitsshallbeprovidedinthechargers tolimittheripplecontent(peakto peak) in the output voltage to 1% irrespective of D.C Loads.

(i) TheD.CSystemshallbeunearthed.sensitiveearthfaultdetectorsshallbeprovide dinD.C system to annunciate earth fault.

(j) Specialdigitalammeterwithzerocentreforstatusofbatterychargingand discharging.

(k) Allothermetersshallbedigitaltypeonly.

ChargerPanelandD.C.DistributionBoard

(a) Battery charger panel and D.C. distribution board shall be sheet metal enclosure free standing type with cable entry from bottom.

(b) Indications, controls and output voltage setting adjustments shall be on front panel. The contractor shall submit a scheme for alarmand trip indication lamps on the cabinet and for fault annunciation contacts paralleled for remote annunciation.

(c) The components shall be liberally rated and housed in a well-ventilated sheet metal cubicle complete with input and output terminals. Louvers shall be provided for ventilation backed up by fine wire mesh so that the degree of protection shall be equal to or better than IP-42.

(e)Busbars shall be of Electrolytic copper Grade conductor of hard drawn (HD) and high conductivity. All busbars shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non- ageing and non-tracking protection, impervious to water, tropical conditions and fungi.

(d) All printed circuit cards shall be plug-in type, interlocked to prevent insertion in a wrong slot. Each card shall have LED indication on its front plate to indicate normal condition and readily and marked test pins.

(e) Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidecovers.

(f) All components shall be accessible to the maintenance technician for easy disassembly and replacement. Access to parts of equipment shall be with minimum danger from all hazards.

(g) All components and modules shall be clearly and unambiguously marked and all wiring colour- coded and tagged.

(h) All power and control wiring within the cubicle shall be done with stranded copper wires. The power wiring shall be adequately sized for the required rating. The minimum sizes for control wiring shall be 1.5 sq.mm and for power wiring shall be 2.5 sq.mm650 / 110V grade.

(i) Groundterminalswithisolatinglinksshallbe provided.

(j) Cableglandsshallbeprovidedtosuittheincomingandoutgoingcables.

(k) DCDBshallmeettheemergencylightingrequirementalso.

Components/ Accessories

(i) The main items are listed below. However, additional items required for completeness or tomeet the specified performance or operational requirements of the charger, shall be deemed tobe included in the contractor’s scope. Instead of incoming ON / OFF switches, sticker fuses and contactors, the contractor may provide suitably rated 3 pole MCBs with overload and short circuit protection and auxiliary contacts.

(ii) One (1) set - Three phase full wave half-controlled bridge rectifier circuit comprising silicon- controlled rectifiers and silicon diodes complete with resistor / capacitor network for surge protection. The diodes / SCRs shall be individually protected by fuses with fuse fail indication.

(iii) One(1)Doublewound,drytype,threephasessuitablyratedmainstransformer.
(iv) One(1)setofsuitablyratedcontroltransformersforelectroniccontroller.
(v) One (1) Electronic controller comprisingof power supplycard, soft start cumcurrent limit card, auto trickle mode card with facility for setting trickle charge current and monitoring battery current, error amplifier cards and pulse generating cards for achieving the DC output voltage stabilisation of ± 1% and also for achieving current limiting feature. The electronic controller shall have protection features with indications for under-voltage, over-voltage, set outputvoltage and phase failure or voltage unbalance.

Theelectroniccontrollershallbeprovidedwithfollowingfeatures.Boostcurrentstabilizationof±2% with AC input variation of voltage and frequency variation of ± 10% and ± 5% respectively.

- Boostchargecurrentlimiterwithpotentiometertoadjustthesetting.

(vi) Adequatelysizednecessarybuilt-inaccessoriesshallbeprovidedsuchthatonfailureofthe controller in auto mode the voltage can be effectively controlled manually.
(vii) One (1) Filter circuit comprising of smoothing choke and condensers complete with HRC fuse with trip indication for filter condenser circuit.
(viii) One(1)Auto/Off/ Manualselectorswitchforselectingthemodeofoperationofthecontroller.
(ix) One(1)frontpanelmountedpotentiometerforsetpointadjustmentofoutput voltageinauto mode.
(x) One(1)frontpanelmountedpotentiometerformanualadjustmentofvoltageinmanual mode.
(xi) One(1)TPACON/OFFswitchforfloatchargerincoming.
(xii) One (1) set of MCB / HRC fuses complete with fittings for AC input with suitable ratings and trip indication.
(xiii) One(1)setofthepilotlampswithseriesresistorstoindicatefloatchargerACMains ‘ON’ condition.
(xiv) One(1)Digitalvoltmeter,ammeterandfrequencymeterforMains.
(xv) One(1)ACcontactorwithsuitablyratedcoilandthreemainand2NO+2NCauxiliary contacts, suitably rated thermal overload relay and ON / OFF control switch.
(xvi) One(1)setofHRCfusescompletewithfusefittingsfortheDCoutput,andwithtrip indication.
(xvii)One (1) movingcoil DC ammeter, with shunt, of size 96 x 96 mmand suitablerange to read the float charger output current.
(xviii) One (1) movingcoil DC ammeter, with shunt, of size 96 x 96 mmand suitablerange to read the charging and discharging current for battery.
(xix) One(1)DoublepoleDCON/OFFMCBswitchforfloatchargeroutput.
(xx) One(1)pilotlampwithseriesresistortoindicatefloatchargerDC‘ON’condition.
(xxi) AnnunciationSystemwithcommunicationfacilityforthefollowing

- ACSupplyFailure.
- RectifierFuseFailure.
- SurgeCircuitFuseFailure.
- FilterFuseFailure.
- LoadLimiterOperated.
- ChargerTrip.

- Batteryon Float.
- Batteryon Boost.

PowerElectronicComponents

(a) Diode and thyristors shall be of monocrystalline type silicon, capable of continuous output at specified voltages. It shall have high power efficiency.
(b) If manydiode orthyristor assemblies areconnected inparallel,careshallbetakentoensurethat each rectifier or thyristor operates within its rating and shares the load uniformly. This may be achieved with the help of chokes. Also, care should be taken to select matched pairs of rectifier heat sink units.
(c) Each diode or thyristor built in a multi-built assembly shall be provided with a short circuit protection to avoid complete shut-down of the equipment because of a fault on single unit. Suitable fuses shall be provided for such protection.
(d) Necessary spare capacity shall be built in the equipment to continuously supply full load even with one unit out of circuit.
(e) Thediodesorthyristorbanksshallbenaturalair cooled.
(f) The diodes or thyristors shall be protected against over voltage due to chopping surges with the aid of snubbers (i.e., resistor-capacitor combination and Metal oxide varister). It shall beensured that normal load currents and especially fault currents are shared equally between parallel links, within the specified limits. To achieve this, great care shall be taken to design the layout of the rectifier links to ensure equal lengths of busbars and as near as possible identical contact resistance in each current path.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

VariableFrequencyDrives

VariableFrequencysystemshallhaveprovisionsuchthatinter-operabilitywithinstrumentationcontrol system for flow control.

ApplicableStandards

(a) Specificationformetalclad base IS:5921 materialsforprintedcircuitsforuse inelectronicandtelecommunicationequipment
(b) SpecificationofTransforme rsand IS:6297 Inductors(Power,Audio,PulseandSwitc

hing) for Electronic Equipment

(c) Semiconductorrectifierequ ipment IS:6619 safetycodefor

(d) Specificationforprintedw iring IS:7405 Board

(e) Recommendedpracticeforemergencyand standby power systems for industrial and commercial

application.

IEEE:446

(f) Semiconductordevices IS:3700

(g) Basicclimateformecha nical IS:9000 durabilitytestsforelectr onic

components

(h) Environmental requirements of semiconductor

IS:6553 devices and integrated circuits

(i) Ambienttemp.of electronic IS:9676 Equipment

(j) Terminalforelectronicequi pment IS:4007

Configuration

Frequency drives shall have one of the two configurations given below Suitable for induction motor protectionofall typesconfirmingto IS12615/IEC60034/ IS13947(Part4/set1)1993/ IEC947-4-1(1990):

(a) Currentsourceinverter.
(b) Voltagesourceinverter.

Converter

TheConvertershallbeoffullwaverectifiertypewithminimumnumberofpulses6or more Smoothing Reactors for Current and Voltage Source Inverter.

(a) Thesmoothingreactorshallbesizedtoavoidconditionsofdiscontinuouscurrent
(b) Drives shallhave ultra-lowharmonic drive (ULH)to reduce harmonic

reduction toless than 5% THD_i(total harmonic distortion-current and voltage). Modern, compact, all-in-one solution that

ensures harmonics are mitigated at source at all loads when connected to either a mains or generator supply.

(c) Operation of the frequency converter at its lowest frequency of operation, which shall not beless than 5Hz.

(d) The smoothing reactor shall be uniformly insulated and shall be protected for voltage surges occurring during sudden load throw-off.

(e) The smoothing reactor shall be made from electrolytic grade copper and shall be epoxy encapsulated with suitable class of resin decided from techno-economic considerations and performance requirements in conformity with IEC-146.

(f) Drivesshallhavecoolingfansforadditionalenergysavingduringpartialloadsituations.

(g) Semiconductorfuseshallbeprovidedforprotectionofdrive.

(h) Drivesshallhavebuilt-inEMCfilterssuitablefornetworkconnectionasstandard.

(i) Drivesshallhavefollowingfeatures:

(i) Level control.

(ii) Pumpcleaning.

(iii) Intelligentmulti-pumpcontrol.

(iv) Flow calculation.

(v) Pumpprotection.

(vi) Quickramps.

(vii) Turbidityreduction.

(viii) Communicationslossbackupmode.

(ix) EMCcompliance.

(x) Modbus protocol.

(xi) Safetorqueoff.

Inverter

Theinvertersystemsuitableforthreephaseoutputshallconsistofthefollowingsubsystems:

ThebasicinvertercircuitconsistingoftheswitchingdevicesayThyristors/ Transistors/IGBT/ MOSFET, connected so as to supply three phase power.

(a) The logicnetwork toenablerapid transitionofthe maininverterswitching devices from on-state to off-state.

(b) Suitable feedback system to allow balance of reactive power flow during load power factor fluctuation as well as regeneration.

(c) The filter system of the inverter output to suppress 5th, 7th, 11th, 13th harmonics atthe output of the inverter to less than 5% of the fundamental amplitude.

(d) Theripplecontrolsystem tolimitcurrentrippleto4%attheinputterminalsofthe inverter caused by distorted current output.

Theoutputfrequencyofinvertershallbecontrolledtowithinthe limits.

InverterforACdrive

(i) CurrentSourceInverter

(a) ConstantTorque Operation
Thecurrent output bythe DClinkshallbe accuratelymonitoredso thattheratioof the terminal voltage of the motor and the corresponding frequency remains constant. Necessary protective featuresfortrippingthefrequencyconverter,alarm/annunciationandfaultdiagnosticsshallbe provided.

(b) ConstantHorsepowerOperation
Inthistypeofoperation,themotor'sinternalvoltageshallbemaintainedwithin+1%whilethe frequency of the inverter shall be varied to meet the duty cycle requirements. Necessary protective features for tripping the frequency converter, alarm / annunciation and fault diagnostics shall be provided.

(ii) VoltagesourceInverter

(a) ConstantTorque Operation
The DC voltage input to the inverter shall be accurately monitored to maintain the ratio the terminal voltage of the motor to frequency at the rated / design value. The DC voltage input shallbemaintainedwithin+1%oftherequiredvalue.Shouldthisfallforanyreason,necessary action for tripping the frequency converter and initiation of annunciation / alarm and fault diagnostic shall be provided.

(b) ConstantHorsepowerOperation
Inthistypeofoperation,thevoltageattheterminalsofthemotorshallbemaintained within+
1%oftheratedvaluewhilethefrequencyoftheinvertershallbevariedtomeetthedutycycle requirements. Necessary protective features for tripping the frequency converter, initiation of alarm / annunciation and fault diagnostic shall be provided.

OutputOvercurrent Limit

Unless otherwise stated, the inverter shall be capable of being temporarily overloaded to 150% of its fullloadamperecapacityforsixty(60)secondsbeyond whichacurrentlimitactionshallbeinitiated, and an alarm contact initiated for annunciation.

ControlModules

All elements of the controlsystemshallbe mounted onepoxylaminate boardsandeach board shallbe a plug-in module mounted on a standard nineteen-inch rack which shall be accessible from the front.
EachcardshallhaveLEDindicationonitsfrontplatetoindicatenormalconditionofthecard.Readily accessible and clearlymarked test pins shall be provided at the important points on the cards to enable signal analysis.

The epoxy laminates shall be free from manufacturing errors and shall be designed to prevent incorrectinsertioninthecardrack.Thecoppersideofthecardshallbesuitablylacquer

edtoprevent oxidation. The gap between two cards shall be sufficient to permit adequate ventilation.

Adjustmentssusceptibletochangebyaccidentalcontactshallbelockable.

ControlRequirements

Shorttimevoltagedipsupto80%ofnominal(e.g.,incaseoflargemotorstart-upconnectedtosame bus) shall not cause the control system to stop functioning and shall not trip the drive system.

Thedrivemotorshallbespeedregulatedcorrespondingto4 -20mAor0 -10Vreferenceinputsignal.
Uponcompletelossofusersspeedreferencesignal,thedriveshallautomaticallyrunat constantspeed as determined by the last speed reference available prior to loss of the signal.

TherequiredprovisionforinterfacingwithPLC/ DCS,includingdetailsofcommunicationmodule and data transfer facility, I/O details shall be furnished by the Bidder.

Protection

ProtectionofPowerSemiconductor

Eachpowersemiconductorshall beprotectedagainst shortcircuit.ThefuseshallbesizedsothatitsI^2t does not exceed the I^2t characteristic of the power semiconductor itself.The voltage and current rating of the fuse shall match the duty on the power semiconductor. The arc voltage, due to melting of the fuse shall not exceed the repetitive peak reverse voltage of the power semiconductor.

Thyristorfusesshallhaveatripindicatortooperateasuitablemicroswitchwithatleast1NO +1NC potential free contacts for annunciation and / or tripping.

Afast-trippingfeedercircuitbreakershallbeusedincasefusesforshortcircuitprotection of thyristors are not used.

ProtectiveSystemsforACInverterDrive

Fusesforallpowersemiconductorsand/ orotherdeviceslikecommutationchokes,capacitorsetc. which are not adequately protected against flow of abnormal currents.

Undervoltageandovervoltageprotectionontheinputside.Lossofinputvoltagetoinver tershall entail tripping of the inverter.

Protectionforallcontrolcards,powersupplystabilizers,filtercircuitsetc.Protecti onshallbe provided such that failure of a part does not cause damage elsewhere in the system.

- Polarizingrelaytopreventreversalofpolarityontheinputsideoftheinverter.
- Protectionofinverterthyristor,commutatingcircuitsandotherinverterelement sduring regenerative operation of the inverter and also during sudden load throw-off.

- Currentlimitfusesattheoutputoftheinverter.
- Commutationcircuitundervoltage.
- Inverteroverfrequency.
- Programmableovercurrent.
- Phasesequence/ lossofphaseprotection.
- Earthfaultprotection.

- DClinkovervoltageprotection.
- Specificmotorprotection.
- Incominglinesurgeprotection.
- VentilationLoss.
- Overtemperature.

CoolingofPower Converters

Powersemiconductorsshallbemountedonheatsinkwhichcanbeindividualorcommo ntoanumber of devices. Adequate provision for clamping and mounting the power semiconductors shall be available.

Cooling of power semiconductors can either be natural air cooled or forced air cooled. The BIDDER shallrecommendthetypeofcooling.However,forpowerconverterswhichexceedcapa citiesof2kA continuous load, alternative cooling methods as oil or water cooling shall be considered. The power semiconductors shall preferably be double side cooled.

SwitchingDevices

Switchingdevicessuchascircuitbreakers,isolators,contactors; switch-fuseunitsetcshallbe considered in the scope of supply.

Theswitchingdevicesshallbeenclosedinaseparateenclosureformingtheset ofpanelsforthepower converters. They shall have adequate clearance both with adjacent devices and metalwork at earth potential. Connection between devices shall be by adequate size of electrolytic grade of copper strips. These connections shall be adequately braced and insulated.

ConstructionalFeatures

Thecontrollershouldhavemodularconstructiontofacilitate maintenance.

Thedriverating22kWandabovethereisaseparate(VFDpanel)panelshallbeprovided andinstalled in Air Condition room, it shall not club with PCC / MCC panels. For protection semiconductor fuse shall be provided for Variable Frequency Drives (VFD).

Busbars

Power connections shall be of the bolted type and mating surfaces shall be tinned. The bus bars runningtovariousconvertersshallbesuitablydesignedtoensureequalsharingbetwe entheparallel strings and prevent mechanical stress on the fuse.

All bus bars shall be of Electrolytic copper Grade conductor of hard drawn (HD) and highconductivityAllbusbarsshallbeinsulatedwithclosefittingsleeveofhard,smooth, dustanddirtfree, heat shrunk PVC insulation of high dielectric strength, to

provide a permanent non-ageing and non- tracking protection, impervious to water, tropical conditions and fungi.

Allcubiclesshallhavecopperearthbusesofadequatesizerunningtheentirecubicleheight alongthe sides.

Cubicle

CubicleshousingthepowersemiconductorsanddrivelevelcontrolsystemshallconformtoIP42 degree of protection to enclosures.

Panelsshallbefreestanding,floormountingtypeandshallcompriserigidweldedstructuralframes enclosedcompletelywithcold rolled sheet steel of thickness no less than 2.5 mmfor front and rear portions and 2.0 mm for sides, top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidecovers.

All doors, removable covers and panels shall be gasketed all round with neoprene gaskets, exhaust fans,ventilatinglouversshallhavescreensandfilterstoheatdissipation.Thescreensshallbemadeof either brass or GI wire mesh.

Design,materialselectionandworkmanshipshallbesuchastoresultinaneatappearanceinsideand outside with no welds, rivets or belt heads apparent from outside, with all exterior surfaces true and smooth.

Painting

All sheet steel work shall be phosphate coated in accordance with the following procedure and in accordancewithIS:6005“CodeofPracticeforPhosphatecoatedIronandSteel”Oil,grease,dirtand swarfshallbethoroughlyremovedbyemulsioncleaningRust andscaleshall beremovedbypickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

Afterphosphatecoated,thoroughrinsingshallbecleanwaterfollowedbyfinalrinsingwithdilute dichromate solution and even drying.

Thephosphatecoatingshall befollowedbytheapplicationoftwocoatsofreadymixedstovingtype zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved.

Afterapplicationofthetwocoatsofprimerfinishingsyntheticenamelpaintshallbeapplied,each coat followed by stoving. The second finishing coat shall be applied after completion of tests.

Thefinal finishedthicknessofpaintfilmonsteelshallnot belessthan80micronsandshall not be more than 100 microns.

Finishedpaintedsurfaceofpanelsshallpresentanaestheticallypleasingappearancefreefromdents and uneven surface.

Asmallquantityoffinishingpaintshall besuppliedforminortouchinguprequiredatsiteafterthe installation of the panels.

BinsandPrintedCircuitCards

Individualbinsshallbemountedonaswingableframesothattheconnectionsattherear arealso accessible.

Self-retainingthumbheadscrewsshallbeneededforholdingthebinsinposition.Adequaten umberof card/ binextendersfortestingofPCBsshall beprovided,eachwithflexiblecablesatleasttwometers long. These extenders shall be of a universal type suitable for use with any card / bin as the case may be.

Alladjustmentswhicharetobemadewhilechangingacardshallbeoutsideinaseparat emodule preferably plugged into the regulator bin.

Locking of individual cards in a bin shall preferably be through self-retaining thumb-head screws. Control modulesshall beintheformofplug-inpackages,pluggedintoamodulebin.Eachplug-in unitshallconsistofastrongframeonwhichaprintedcircuitboardwouldbepermanentl yscrewed. The plug connections shall only be of the pin type.

The printed circuit board (PCB) shall be made of glass fibre filled with epoxy laminates. The plug-in unitshallbescrewedtothebasicsocket inthemodulebinwithlongthroughboltsandknurledheads.

Thefrontplatesoftheplug-inunitshallhavetheswitches,thepotentiometers,miniaturemonitoring meters, test points etc. Each plug-in unit shall have its own identification legend.

Allplug-inunitsshallbepolarizedtopreventincorrectinsertionsintothemodulebin.

Thegapbetweentwoplugsinunitsinsideabinshallbesufficienttopermitadequate ventilation.

Thecoppersideoftheprintedcircuitboardshall belacqueredtoprevent oxidation.Eachsideofthe printed circuit board shall have a shield cover to prevent inter circuit and external interference.

ThePCBshallbemountedonPCBguidesfixedonstandardracksandtheshieldproperly grounded. Control circuit test points shall be easily accessible for monitoring and maintenance.

Annunciation

The annunciate shall work on DC power supply with communication facility (RS 485 port) Fault and TripshallbeseparatelycommunicablewithPLC.Eachannunciatewindowshallhavet woLEDlights connected in parallel which operate at not more than 75% of their rated voltage. Window shall be arrangedinalogicalgroup.Theannunciateshallhaveamoduleconstructionwithglass epoxyplugin cards.

Electronichooter/Alarmbell/

sirenshallbecontinuouslyrated,TheAnnunciatorshallhavethe following facilities:

(a) Firstinsequence,memoryreset.
(b) faultsshallbememorized.
(c) Test Feature.

Thereshallbeathree-tiersystemofprotectionand annunciation:

(a) Alarmbothaudibleandvisual.
(b) Warningwithdelayedshutdowntimedelaythroughatimerofrange0-60sec.
(c) Disturbance associated with failures of systems elsewhere with serial communication port.

Meters

Individualmetersshallbeprovidedforspeedreference,speedfeedback,currentreference,current feedback, pulse output, and regulated power supply voltages.

Allmetersshallbeidenticalandfedthroughindividualbuffer ICamplifiers.Allmeterssh allbethe circular scale type having a full-scale deflection of 270deg. All meters shall conform to at least accuracy class 1.0

All meters with their individual buffer amplifier cards shall be housed in separate bin. It shall be recommendedthatthebufferamplifiersallbehousedonasingle/twocardsandthiscardbeitself/ themselves housed in the regulator bin.

Sensitive signal leads in that case shall not have to traverse from one bin to another, only noise insensitivebuffer amplifieroutput leadsshallneedtogotothemeterbin.Selectorswitchesifused with any meters shall have pistol grip handles.

Wiring

Stranded,flexiblecoppercableof2.5sq.mmshall beusedforCT circuitsand1.5sq.mmforother control circuits. However, for PCB terminals 0.75 sq.mm tinned copper wire may be accepted.

Ultra-flexiblecablesshallbeusedforallconnectionsfromafixedparttoamovablemember.In addition, a hanging loop of sufficient length shall be provided to avoid any cable stressing.

All terminalboardsforoutgoingconnectionsshallbeat aheight ofat least 250mmfromthecubicle floor, and preferably tilted at an angle of 45^0 to the horizontal for ease of connections. Similarly, connectionoftheincomingpower cablestothebusbarsshallbedoneat aheight ofatleast250mm from the cubicle floor.

ItemdesignationandlocationmarkingshallbeinlinewithIECrecommendations.

Devicelabellingshall beonitsfixedmountingandnotonthedeviceitselfsuchthat labellingremains even when the device shall be replaced. Metallic labels / paper labels or sticker shall be accepted.

Non-SegregatedBusDuct

BusEnclosure

- Theenclosureshallbemadeofaluminiumalloywithminimumthicknessof3mm.

- Stiffenersshallbeprovidedwherevernecessarytostrengthentheenclosure.
- Busbarcrossovershallbeavoidedandshallbesuitablycoordinatedwithtransformer manufacturer and panel manufacturer by the contractor.
- Silicagelbreatherandspaceheaterwiththermostatshallbeprovidedas required.
- The entire bus duct shall be designed for indoor / outdoor installation, with a dust and vermin-proofconstruction.Busductinstallationsmeantforoutdoorapplicationshallbeof weatherproof construction and shall have degree of protectionbetterthanorequalto IP-55 Outdoor portionof bus duct shall be provided with rain hood.
- The inside of the bus enclosure shall be treated with a matt paint of dark colour, preferablyblack to facilitate efficient heat dissipation. The bare enclosure with above painting shall be designed so as not to exceed the temperature specified in IS:8084 and MS epoxy painted with outer shade of Epoxy paint of shade 631 of IS 5. Paint thickness shall be not less than 100 microns.
- Joints consisting of metallic expansion bellows shall be provided on the bus enclosure at following points:
  (i) Atterminationsattransformers.
  (ii) Atterminationsatswitchgearcubicles.
  (iii) Intherunofthebusductincaseoflonglengthsas required.
- Flexible expansion joints for the enclosure shall be provided wherever deemed necessary. The flexible joints shall take care of expansion and contraction due to temperature variations and fault conditions.
- Necessary bonding shall be provided at the above expansion joints if joints are made of insulating material.
- Three-phaseterminal enclosuresshall beprovidedwithflangedendswithdrillingdimensionsto suit the flange at equipment terminals.
- Theflangesshallbeprovidedwithgaskets,nuts,bolts etc.
- Provision shall bemade forperiodicinspectionofinsulatorsbymeans ofinspection covers.The inspection covers shall be provided at the bottom with quick-acting stainless-steel clamps and shall have gaskets. There shall be no joints or fixing bolts on the top surface through which water could seep through.
- Thedrainplugsshallbeeasilyremovableforcleaningpurposes.
- The gasket material and thickness shall be so selected as to satisfy the operating conditions imposed by temperature, weathering, durability etc. Care shall be exercised to ensure thatcovers fit easily, that the required compression of the gaskets can be obtained without damageto the inspection covers by bolts and that covers do not bend after this compression has been applied Over-compression of the gaskets shall be avoided.
- Thematerialofthegasketshallpreferablybeneopreneclosed-cellspongerubberor equivalent.
- Flangegasketsshallbeprovidedattheequipmentterminal connections.
- The bus duct shall not have any through bolts. All nuts and bolts shall be mild steel hot dip galvanized GS spring washers shall be provided for making satisfactory joints Clamps, splice plates etc shall be provided wherever necessary.

- Wheneverthe outdoor portion of the bus duct shall beof flanged construction butof boltedtype acontinuoushoodmadeofnon-magneticmaterialshallbeprovidedovertheentirelengthofthe outdoor portion of the bus duct to prevent ingress of water particles due to heavy rain fall directlyonbusductenclosure.Thishoodshallbemountedonbusductsupportingstructures

and all hardware and accessories required for mounting the hood shall be included in scope of supply.

BusConductor

- ThematerialoftheconductorshallbeofECgradealuminiumalloy.
- Thetemperature rise of conductor shall be as per IS:8084. Also,the temperature of the bus shall not exceed 250˚C while carrying the specified short circuit current for one second when a fault occurs at the operating temperature.
- The bus conductor shall be given a coat of matt black paint to facilitate heat dissipation. The bare conductor with above painting shall be designed to carry the normal rated current without exceeding temperature rise as specified in IS:8084.
- Bus bars shall be colour coded with colour PVC tape at suitable intervals for easy identification.
- Flexible aluminium connectors welded to the main busbars shall be provided wherever deemed necessary.
- Theconnectors shall be of the same material as the conductor andjointsshall besilver-plated to ensure an efficient connection. The bolting schedule and contact pressure shall conform to accepted codes of practice.
- Flexible braided copper connections shall be provided at the equipment terminal such as transformer end and PCC / MCC end connections. Bimetallic connectors shall be provided between the busbar and the copper flexible if the bus conductor shall be of aluminium alloy.The joints shall be capable of 25 mm settlement of the equipment mounting pads. The joints shall be suitably designed to take care of the vibration at the terminals as well as the expansion and contraction of the busbars.
- Expansion joints made of aluminium strips shall be provided wherever deemed necessary, to take care of expansion and contraction of the busbars under normal operating conditions.
- All the abovejoints shall be testedfortemperature rise to prove the adequacyof the design.The maximum temperature rise at the joints shall be less than the specified temperature rise for the busbars.
- The busbar clamps at insulators shall be designed to withstand the forces due to momentary short circuit current. They shall permit free longitudinal movement of the bus bars during expansion and contraction. The material of the clamps shall be aluminium alloy Suitable aluminium spacers shall be provided wherever necessary.
- All bolts, nuts and lock washers used in the bus assembly shall be of high tensile steel, platedfor corrosion resistance spring washers of “Beleville” type or equivalent shall be used.
- Suitablespliceplatesandbimetallicconnectorsshallbeprovidedwherevernecessary.
- Disconnecting links with rating same as that of the main busbars shall be provided in the run of the bus duct to facilitate disconnection of the busbars during testing and maintenance. The separation of the busbar sections with the bolted links removed shall be sufficient to withstand the rated voltage of the bus duct.
- Shorting jumpers, for the purpose of drying out the equipment before

commissioning or for carrying out short circuit test on the equipment, rated for the main bus current shall be supplied for shorting the bus duct at a location, adjacent to the disconnecting links.

- The shorting links shall have drilling dimensions matching those of the main bus disconnecting links. Suitable supporting structures and support insulators for the shorting links, if necessary, shall also be offered.

PhaseBarriers

- In segregated phase bus duct if metal barriers are provided, the material shall be same as that of the bus duct enclosure material.
- Insulated phase barriers, when specified, shall be made of non-hygroscope insulating material such as fibre glass

BusSupportInsulators

- Within the bus duct the bus shall be mounted and supported on insulators. The insulators shall be mounted on resilient pads provided in the bus enclosure.
- Theinsulatorsshallbeeitherporcelainorresincastflameretardant,non-hygroscopic,high creep and high strength type.
- For bus ducts with voltage rating up to 1100 Volt, Fibre glass / FRP or equivalent type of non- hygroscope insulating supports are acceptable.

WallFrameAssemblyandSeal–off Bushing

- Wherever the bus duct passes through the plant building wall, from indoors to outdoors, a wall frame assembly with seal-off bushings shall be provided to prevent any leakage of rainwater, infiltration of dust and air temperature variations fromindoors to outdoors.The wall frame shall be fabricated out of aluminium angles and sheet and shall be suitable for grouting in the wall. It shall be provided with flanges on both sides to receive the bus duct flanges. A suitable size breathershallbeprovidedforthetwosectionsofthebus-ductbetweenthewallframeassembly.
- The bus duct shall be equipped wherever necessary with seal-off bushings to preventinterchange of air at different temperatures. The seal-off bushings shall be flanged type.
- The insulator for wall frame assembly and seal-off bushings shall be of porcelain. Also, the bushings shall be designed for thermal expansion / contraction due to temperature differentialfor outdoor / indoor use.

BusDuctSupports

- The supporting structure shall be fabricated from standard steel sections and shall be hot dip galvanized after fabrication. The hot dip galvanizing shall be in accordance with standards.
- Calculations shall be furnished to substantiate the strength support structure to withstand the various static and dynamic loadings.
- The supporting structures shall include supporting members, brackets, hangers, longitudinal beams, channels, nuts, bolts, washers and all other hardware. which are necessary for the erection and support of the entire bus duct installation. All the accessories and hardware of ferrous material shall be hot dip galvanized.

- Studs, nuts, bolts and tapped holes shall conformto the relevant standards. Only hexagonal nuts shall be used. All bolt holes shall be spot faced for nuts.

- Castings and forgings shall conform to respective material specifications and shall be free from flaws. They shall be machined true as per good workshop practice. Welding shall be performed in accordance with relevant recognized standards.
- All threaded pipe connections and fittings, pipe flanges and tube fittings shall comply with relevant standards.
- Indoorportionofthebusductmaybesupportedfromthefloororceilingbeams.
- Outdoor portion of the bus duct shall be supported from ground below on suitable foundation in the ground.
- The foundations and structures in outdoor area shall clear the transformers, transformer foundations, cable trenches.
- All the bus supports shall be adequately supported and braced to successfully withstand normal operation, vibration, thermal expansion, short circuit forces and all specified design loads.
- A separate run aluminium alloy of suitable size clamped along both sides of the enclosure shall be provided as the earth bus. All the parts of the bus enclosure, supporting structures and equipment frames shall be bonded to earth bus. at least two earth pads shall be provided to connect the riser fromstation earthing bus. All necessary hardware, such as clamps, connectors, etc required for this purpose shall be furnished by the BIDDER.

ElectricalMotors

General

ElectricmotorsshallcomplywithIS12615, IS15999,BS4999andBS5000,IEC60034,IEC60072 and IEC 60085 and shall be bi-directional and rated on the basis of duty type S1 (maximum continuous rating).

Where the power supplypermits motors shall bepreferentiallyof the 3-phase type.Motorsshall be suitablefortwostartsinsuccessionfromhot underthespecifieddutyconditionsofloadtorqueand inertia and shall also be suitable for six equally spaced starts per hour under similar conditions.

Motors shall be designed tooperate on the supplyvoltage specified for the Works. Motors shall be capableofoperatingunderconditionsofthreephasesupplyimbalancewherethenegativeandzero phase sequence components of the voltage do not individually exceed 2% of the positive phase sequence components.

ApplicableStandards

SL.NO.	BRIEFNAME	REFERENCE STANDARDS
1.	EnergyefficientInductionmotors– Threephase Squirrel Cage	IS–12615/IEC60034-30-1
2.	Standardmethodsfordeterminglossesand efficiency from tests	IS-15999(Part2/Sec1)
3.	Permissiblelimitsofnoiselevelforrotatingelectrical machines	IS–12065/IEC60034-9

4.	Mechanicalvibrationofrotatingelectricalmachines	IS–12075

SL.NO.	BRIEFNAME	REFERENCE STANDARDS
5.	GuidefortestingthreephaseInductionmotors(For standard TEFC SCR motors)	IS–4029
6.	Methods of determination of efficiency of rotating electricmachines(ForstandardTEFCSCRmotors)	IS–4889
7.	Coloursforreadymixedpaintsandenamels	IS–5
8.	Electricalinsulation-Thermalevaluationand designation	IS–1271
9.	Dimensionsofsliderailsforelectricmotors	IS–2968
10.	Dimensionsofverticalshaftmotorsforpumps	IS–2254
11.	Valuesofperformancecharacteristicsforthreephase induction motors	IS–8789
12.	Guidefortestinginsulationresistanceofrotating machines	IS–7816
13.	Designationfortypeofconstructionandmounting arrangement of rotating electrical machines	IS–2253
14.	Guide on effects of unbalanced voltages on the performanceofthreephasecageinductionmotors	IS–13529
15.	Guideforselection&applicationofthreephase induction motors for different types of driven equipment	IS–13555
16.	Codeofpracticeforinstallationandmaintenanceof induction motors	IS900
17.	DimensionsoffootmountedACInductionmotor.	IS-1231
18.	DimensionsofflangemountedACInductionmotors	IS–2223
19.	Rotatingelectricalmachines–rating&performance	IS-15999/IEC60034-1
20.	Degreeofprotectionprovidedbytheintegraldesignof rotating electrical machines (IP code): classification	IS/IEC60034-5
21.	Designation of method of cooling for rotating electricalmachines/methodofcooling(ICcode)	IS6362/IEC60034-6

22.	Terminalmarkingsanddirectionofrotationfo r rotating electrical machines	IS/IEC60034-8
23.	Dimension&outputratingofrotatingelectric al machines	IEC60072-1

Construction

Motorconstructionshallprovideadegreeofprotectionasfollows:

IP55-

useinapplicationsindustyenvironments.

IP 65 - external use in exposed location.

Motormountingarrangementshallbetosuit application.

Motor coolingshall betotallyenclosedfan cooled (TEFC) withshaftdriven bi-directional fans.Type ofcoolingshallbeIC411asperapplicablestandard.Otherformsofventilationmaybeusedwiththe approval of the Engineer.

Motor bearings shall be provided with facilities to add additional lubricant. For grease lubricated bearings grease nipples shall be provided and a grease relief feature incorporated. Oil lubricated bearings shall be provided with site glasses which provide an accurate indication of bearing oil level when the motor is in use. Bearings shall minimum L-10 rating of 5 years (40,000) hours at rated operatingcondition.Motorsratingof37kWandaboveshallhaveonlinegreasingfacilityandratings below shall be provided with sealed bearing.

Stainlesssteelratingshallbeprovidedwithinformationofratings,typeofenclosure,startingcurrent, startingtorque and efficiencyclass.Separatetagplatesshall beprovided for spaceheater,thermistor, RTD.

MotorsshallbedesignedfornormalsoundpowerasdefinedbyIS12615,IS15999,IEC60034orBS 4999 and windings shall be insulated to class F as defined by IS 11182 or BS 2757. However, temperature rise at full load shall be limited to that for Class B insulation.

Wherespecifiedmotorwindingsshallincorporate:

- Thermistors(PTCtype),or
- Resistancethermometers(PT100).

In each instance the temperature detectingdevices shall bein close thermal contact with each phase of thestatorwindings.Allthermistorsshallbeconnectedtogethertoprovideasingleelectricalcircuitfor connection to an external relay which shall be capable of tripping the motor.

Eachresistancethermometershallbeconnectedseparatelytoanexternalmonitorrelaywhichshall offeralarmandtripsettings.Thermal protectionshall beClassIforsizesofmotorupto75kWand Class II above 75kW.

PerformanceandCharacteristicsofLTMotor

(i) Motorsshall be capable ofgivingrated output withoutreduction in the expected lifespan when operated continuously under either of the following supply conditions:

Supply Condition

(a)	Variationinsupplyvoltage from rated voltage	±10 %
(b)	Variationinsupplyfrequency from rated frequency	±5%
(c)	Combinedvoltage and Frequency variation	+10%

(ii) All Motors shall be suitable for the method of DOL starting or star-delta starting or any other method of starting.

(iii) Theminimumpermissiblevoltageshallbe80%oftheratedvoltageduringmotor starting.

(iv) Motors shall be capable of starting and accelerating the load with the applicable method of starting, without winding temperatures reaching injurious levels, when the supply voltage shall be in the range of 85% of the rated motor voltage to maximum permissible voltage.

(v) The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerances as per the applicable standard) unless otherwise specified. The locked rotor currentof VFD controlled motor shall be within the limit of IS 12615 / IEC 60034.

(vi) Motors shall be capable of developing the rated full load torque even if the supply voltagedrops to 70% of the rated voltage. The pull-out torque of the motor shall be at least 205% offull load torque.

(vii) Motors when started with the driven equipment coupled shall be capable of withstanding at least two successive starts from cold conditions & one start from hot condition withoutinjurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.

(viii) MotorsshallbeofEnergyEfficienttype.

(ix) LTmotorsshouldhavethefollowingprovision:
ForMotor>=30kW,anticondensationheatersandseparateauxiliaryterminalboxforheaters shall be provided.

Motorsrated below30kW,duringidleperiods, the stator windingshall be connected toa 24V 1-phase 50 Hz, AC supplyfor heatingand eliminationof moisture. The bidder / manufacturer shall bringoutincaseofanyobjection to the above method of heatingstatingreasons thereof. Awarninglabel,blacklettersonayellowbackgroundshall

befittedtoindicatethat theheater maybeenergised.Heaterterminalsshallbeshroudedonlargermotorsaseparat eterminalbox shall be provided.

Anti-condensation heaters shall be sized to raise the temperature inside the motor several degreesabovethedewpointtemperature,theheatersurfacetemperaturesh ouldnotexceed 200℃. Heaters shall be automatically disconnected when the motor shall be switched on.

(a)Vibration monitoring system shall be provided for measuring vibration in motor body andbearing for Motors > = 75 kW.

SpecificRequirementsofVFDDrivenMotors

The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequencyinverterforspeedcontrol.Themotorshallbesuitableforthecurrentwaveforms produced by the power supply including the harmonics generated by the drive. The motor shall be designed to operate continuously at any speed over the range of rated speed.

Thepermittedvoltagevariationshouldtakeintoaccountthesteadystatevoltagedropacrosstheac drive and all other system components upstream of the motor. The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.

Thedrivenequipmentmanufacturershallbesolelyresponsibleforproperselectionofthemotorfor the given load application and the output characteristics of the driven equipment

LocalPushButtonStation

ForallmotorsLocalPushButtonstationshallbesuppliedshallbeprovidednearthemotors/apparatus for controlling supply to the motor apparatus at an accessible location. For local control of motors, LPBS shall be provided suitable for wall / pedestal mounting. The Local Push Button station shall be complete with all the indication lamps, pushbuttons and shall have the specifications as listed below.

The degree of protection for LPBS shall be IP55 with canopy for outdoor and IP54 for indoor applications.Theenclosureshall bemadeof2mmCRCAsheetsteelandtheinteriorandexteriorof push button stations shall be painted light grey with shade no 631 of IS:5 as per standards.

Minimum Push button for ON / OFF / E-Stop and Local / Off / Remote Selector Switch and indicationlamps(ON/OFF/TRIP)shouldbeprovided.Reversepushbuttonshallbeprovidedfor bi-directional motors. The Emergencypush buttonshall be of red mushroomhead, press to lock & turn to release type.

All push buttons shall be provided with 2 nos. NO and 2 nos. NC contacts for various interlocking purposes.OnecontactofstopPBshallbedirectlywiredtotheswitchgearmodulefordirecttripping and another contact to control system.

The stations shall have sufficient number of terminal blocks with 20% spare. The wirings shall be donewith1.5Sq.mm,multistrandcopper,1.1kVgradePVCinsulated,greycolour,highlyflexible wires having ends provided with identification ferrules and crimped tinned copper logs. Suitable plugs are to be provided to seal the unused cable entry opening. The glands shall be double compression brass

type and shall be weatherproof. The local Push button shall be mounted at 1200mm from the floor level.

ThePBstationshallbesuitableforwallorstructuremounting,providedwithlabels, earthing terminals, suitable lugs glands.

PBstationshallbeofoneofthefollowingtypes

Type A - ThreePB'sforward-reverse-Stopforreversiblemotors. Type B - Two PB's start-stop for non-reversible motors.

TypeC - OnePBSTOPfor emergency.

CableTerminations

CableterminationboxesshallhaveIP55andshallbesuitableforairterminationofcables.Theyshall be sealed with a neoprene gasket to provide dust and weather protection. Terminal box shall be suitable for top and bottomentryof cables and shall be capable of rotation in steps of 90 Deg through 360 Deg.

Cable boxes for voltages in excess of 1000 shall be treated with anti-tracking varnish.

Separateterminalboxesshallbeprovidedforspaceheater,thermistorwithcautionplates. When single core cables are used, gland plate shall be non-magnetic material.

JunctionBoxes

ForLTmotorsof18kWandabove,powerjunctionboxesshallbeprovidedwhere3corealuminium shall be terminated, and copper flexible cables shall be taken from it to the motor terminals.

ThedegreeofprotectionforJBshallbeIP55foroutdoorandIP54forindoorapplications with20% spare terminals.

Cables:MV,LV Power,ControlandTelecommunications

ApplicableStandards

Thecablesshallconformtothelatestapplicablestandardsspecified below

SL.NO.	ITEM	
1.0	**APPLICABLESTANDARDS**	
1.1	Typeof conductor	IS8130 IEC60228
1.2	ConductorScreening	IS7098 IEC60502

1.3	Insulation	IS5831 IS7098 IEC60502
1.4	Armouring	IS3975

SL.NO.	ITEM	
1.5	Testandtest equipment	IS 10810
1.6	OxygenIndex test	ASTM-D-2863
1.7	Temperatureindex value	ASTM-D-2863/NES715
1.8	Cable drums	IS 10418
1.9	Flammability	IS 10810 IEC60331IEC 60332
1.10	Testforsmoke generation	ASTM-D-2843
1.11	Testforacidgasgeneration	IEC60754-1
1.12	TestsforResistancetoUltravioletRadiation	DIN53387
1.13	Telecommunication cable, Low frequencycablesandwireswithPVCinsulationandsheath -GeneralTestsandmeasuringmethods	IS5831 IEC60189-1 IEC 60189-2
1.14	Instrumentationcable	IEC60189-1IEC60189-2
1.15	Construction,performanceandtestingof XLPE Insulated MV Power Cables	IS7098 IEC60502
1.16	Construction,performanceandtestingof 1100V Grade PVC Insulated Power and Control Cables	IS1554 IEC60502
1.17	Construction,performanceandtestingof 1100V Grade light duty unarmoured cables	IS694
1.18	Instrumentcableforoperatingtemperatureupto 400 deg centigrade	JSS51034
2	InstallationofCables	IS1255
3	RecommendedCableRatings	IS3961

FeaturesofConstruction

(a) XLPEInsulatedMVallaluminiumstrandedPower Cables:
The Cables shall be 11kV unearthed grade, heavy duty, stranded aluminium Conductor, grade H4, Class 2, XLPE Insulated, Conductor Screening by extruded. Semiconducting compound, insulationscreeningthroughcombinationofsemiconductingcompoundandnon-magnetictape (Copper tape), inner sheath over laid up cores, galvanized steel wire / strip armoured (Aluminium wire armouring for single core cables), outer sheath of extruded black PVC Compound type ST-2 Core Identification shall be by printed numerals.

(b) LT Power Cables XLPE Insulated Cables:

The Cables shall be 1.1kV Grade, grade H4, Class 2, heavy duty, stranded aluminium for above 6 sq.mm, annealed Copper Conductor class 2 for 6 sq.mm and below, XLPE, insulated, inner sheathed, galvanized steel wire / strip, armoured, extruded black PVC Compound type ST2 outer sheathed.

(c) Control Cables:
The Cables shall be 1.1kV grade, heavy duty, stranded copper conductor, extruded PVC Compound type A Insulated, galvanized steel wire/strip armoured with extruded PVC inner sheath and extruded black PVC type ST1 outer sheathed.

Cable Rating

The Contractor shall ensure that cable and wires associated with the distribution and control systems, plant wiring and all other installations throughout the works are adequately rated for their use.

In assessing the rating of any cable or wire, the following factors shall be taken into account:

- Supply voltage and frequency:
- Maximum voltage drop permissible.
- Type and magnitude of load.
- Fault level and duration related to circuit protection relays and fuses.
- Circuit overcurrent protection.
- Route length and disposition of cables.
- Ambient temperature.
- Method of installation.

All power cables shall be sized for continuous current carrying capacity at the ambient temperature of 45^0C. The design current capacity of any circuit shall not exceed the full load current of the supplied device by at least 10%. Power cables shall be sized to limit the maximum voltage drop to not more than 3%.

Under motor starting conditions the corresponding voltage drop shall not affect the operation of the motor controls or the ability of the motor to start and run effectively and in any event shall not exceed 10%. The Contractor when sizing cables for the remote operation of shunt trip coils shall take due account of the voltage drop caused by the momentary current surge taken at the instant of energisation. MV and LV cables shall be sized for a fault clearance time of 1 second for the incoming feeders and 0.5 second for switchboard feeders controlled by circuit breaker.

Cable Colours

All cable cores shall be colour coded throughout their length and shall be so connected between switchboard, distribution board, plant and accessories, that the correct sequence or ph

asecoloursare preserved throughout the system.

Thecolourcodingshouldbeasfollows:

3 phase	red,yellowandblue
singlephaseordc	redandblack
earth	green/ yellow
control	blue(dc),red(ac)

CableConductors

Copperconductorsshall beusedforcablesofsizesupto6Sq.mmandabove6Sq.mmAluminium conductors shall be used. Cores of cross-sectional area greater than 1.5 Sq.mm shall be stranded. Lightingfinaldistributioncircuitsshallbeofaminimumcross-sectionof1.5Sq.mm.Powercables shall be of a minimum cross-section of 2.5 Sq.mm. Internal wiring of control panels shall be of a minimum cross-section of 1.0 Sq.mm flexible and stranded Control cables shall be of a minimum cross-section 1.5 Sq.mm for external use and 1.0 Sq.mm for internal use.

CableNumbering

All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosionresistantlabel.Cablesofdifferentcategoriesshallbetaggedwiththefollowingsubscripts and three-digit number

MVpower	MV-P___
LV power	P_ _ _
Control	C__ _
Instrumentation	I___
Protection	PR___

CableDrums

Cables shall be supplied in non-returnable wooden drums and shall confirm to IS 10418-2024. The wood used for constructionof the drum shall be properly seasoned and free from defects and wood preservativeshallbeappliedtotheentiredrum.Allferrouspartsshallbetreatedwithasuitablerust preventive coating to avoid rusting during transit or storage.

The Bidder shall indicate in the offer, the maximum length for each size of cable, which can be suppliedononedrum.Theactuallengthsuppliedoneachdrumshallbewithintolerance limitof ±5% without any tolerance on total ordered quantity of each size of cable. However, before winding the cables on drums contractor shall obtain

Employer’s approval for the drum lengths.

Each drum or coil of cable shall be accompanied by a certificate stating the manufacturer's name, cable size and number of cores, length, result and date of tests as required in the Employer’s Requirements. Cables manufactured more than 12 months before delivery shall not be accepted. All cablesshall bedeliveredwithcableendseffectivelysealedbyhygroscopicscalingcaps.Whenacable is cut from a drum both ends shall be immediately sealed to prevent ingress of moisture. Cables shall not be transported to site in loose coils but a number of short lengths of cable may be transported on the same drum. The Contractor shall be wholly responsible for the purchase and / or hire costs of all cable drums and for the removal of these drums from site after use.

CableInstallation

General

Cablesshallbeinstalledinsuchawaythattheminimumbendingradii arenot reducedwheninstalled or during installation. Cables shall not be installed in ambient temperatures below that recommended by the cable manufacturer.

Cablesgroupedtogethershallhaveinsulationcapableofwithstandingthehighestvoltagepresentin the group.

Cablefiresealingshallbeprovidedsuchthatfireproofcablepenetrationsealsratedfortwohoursshall be provided as per BS: 476 (Part - 20) or equivalent standards.

Cablesofdifferentcategoriesshallbeinstalledsoastomaintainsatisfactoryclearancesforsafetyand in ordertoreducethepossibilityofelectricalinterference.Thefollowingtable detailsthedistancesin mm that shall be maintained between the different categories of cable.

TableofSeparationDistancesinmmbetweendifferentCategoriesof Cable

CableCategory	MV Power	LVPower	C&I/Protection
MVPower	Notspecificbutshall suit de-rating factor	300	600
LV Power	600	Notspecificbutshall suit de-rating factor	300
C&I/Protection	600	300	Notspecificbutshall suit de-rating factor
Gas/Watermain	300	300	300

Theseseparationsareminimumandspecialcircumstancessuchasthepresenceofhighcurrentflows, or harmonic content may necessitate larger separation distances.

Inordertomakeeconomicuseofthecablesupportsystem,cablesshallbearrangedingroupsof50 mm maximum overall diameter. These groups shall be securely tied to the cable support system at intervals not exceeding 900 mm for horizontal runs and 300 mm intervals on vertical runs.

Cablesshallbelaidinamannersuchthatanyelectricalinterferencebetweencablesshallnothavea detrimental effect on the life and operation of Plant.

Where practical a separate cable support system shall be provided for power and non-power cables.
Wherethisisnotpracticalaseparationof150mmshallbemaintainedbetweenpoweranddnon-power cables when run on the same support system.

Heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems. Plastic or GRP cable support systems shall be used in areas used for the storage and handling of chlorine.These systems shall be used toroutecablesaround wallsand within cable trenches. Cables shallbesecurelyfixedtothesupportsystemsBundlingofcablesshallbepermittedwhereallowance for this practice has been made in sizing the cables.

CablesLaidDirectin Ground

Buried cable up to 650 / 1100V shall have a minimum cover of 750 mm measured to the top of the highest cable. On crossing roadways, the cable shall be run through a PVC-U duct of minimum diameter100mmwithaminimumof1000mmcover andencasedonallsidesby150mmofconcrete. Cables of greater than 650 / 1100V shall be buried with a minimum cover of 1 m.

Thebottomofthecabletrenchshall befreedofsharpstonesandsuchlikeand75mmofsievedsand laid below the cable. After cable laying 75 mm of sieved sand shall be laid above the cable. Interlocking cable protective covers, minimum 1 m long x 300 mm wide, marked ‘Danger -Electric Cable’ in English and the vernacular shall be laid on top of the sieved sand covers shall extend the wholelengthofthecabletrenchandshall overlapcablesbyaminimumof50 mm.Warningtapeshall be laid a minimum of 200 mm above the protective covers. Cables are to be installed without tees or through joints unless otherwise approved by the Engineer Single core cables shall be run in trefoil formation.

CablesLaidinUndergroundDucts

Underground ducts shall be constructed of impact resistant PVC-U and laid at a minimum depth of 500mm,ductsshall besurroundedbyatleast 75 mmofsievedsandexceptatroadcrossingswhereit shall be 1 m deep and encased on all sides by 150 mm of concrete.

TheContractorshallensurethatsufficientdraw-inpointshavebeenprovidedandthatadequateroom has been allowed for installation of cables. Drawstrings shall be provided in all ducts to enable

additional cables to be installed when required.

Wherecablespassinoroutofanyductentriesintoorwithinbuildingssuchentries,togetherwithany spare ducts shall be sealed against the ingress of moisture by means of duct stoppers and bituminous compoundsor byanyothermethodapprovedbytheEngineer.Thestoppershall haveafireresistance

ofatleast30minutes.Singlecorecablesintrefoilformationshallpassthroughthesa meductand shall not be separated.

Cablesinstalledin Conduit

(a) General

Conduits shall be galvanized heavy gauge solid drawn or welded screwed steel type and be in accordancewithIS9537Part2orBS4568.Accessoriesshalleitherbemalleablecastiro nscrewed type or pressed steel and galvanized.

A space factor of 40% shall not be exceeded, but in any case, conduit of less than 20 mm diameter shall not be permitted. The tubing shall be perfectly smooth inside and out and free from flaws and imperfectionsofanykind.Bothendsofeverylengthoftubingshallbeproperlyreamed withallsharp edges removed before erection.

Whereseveralconduitsconverge,malleablecastironorheavygaugesheetsteeladapta bleboxesshall be employed in order to avoid crossings. Conduits shall be connected by means of male brass bushes and couplings.

Where conduits are greater than 25 mm, straight through joint boxes shall be of the trough type. Where conduit and / or fittings are attached to equipment casings, the material or case of the casing shall betappedforadepthofnot lessthan10mmormalebushesandflangedcouplingsshall beused.

Heavy hexagonal lock nuts shall be used at all positions where running joints are required and great care shall be taken to ensure that they seat firmly and evenly on to the mating faces of coupling or otheradjacentaccessories.Alljunctionboxes,draw-inboxes,andinspectionfittingsshallbesoplaced that the cables can be inspected and, if necessary, withdrawn and re-wired throughout the life of the installation.

Generally, not more than two bends or offsets or one coupling shall be permitted without a suitable inspection accessory. Fish wires shall not be left in conduits after erection. The whole of the installation shall be arranged for a loop-in type of system with joints being carried out at switches, isolators,etcIntermediatejointsinthecableshallonlybeallowedbyarrangementwitht heEngineer. Where terminal blocks are necessary, they shall be of the porcelain type with brass pinching screws.

Ends of conduits which are liable to be left open for any length of time during building operations shallbepluggedtopreventtheingressofdirt,cement,etcandcovers,eithertemporary orpermanent, shall be fitted on all boxes.

Generally,conduitsshallnotcrossexpansionjointsofbuildings,butwheretheycannot beinstalledin any other manner then a flexible conduit shall be used across the expansion joint A total 150 mm movement shall be allowed.

(b) Surface Installation

Surfaceconduitsshallbesecuredandfixedbymeansofdistancespacingsaddlesorapprovedpurpose made clips which allow the conduits to be taken directly into accessories without sets or bends.

Conduitsshallberuninasquareandsymmetricalmanner.Anefficientmeansshallbead optedto provide for the drainage of condensation and the runs shall be properly ventilated.

All surface conduit runs shall be marked out for approval by the Engineer before the installation shall be carried out. Where large multiple parallel conduit runs would occur, use may be made ofgalvanized cable trunking. Conduits installed on structural steelwork shall be secured at spacing not exceedingthoseforsurfaceconduitbygirderclips,otherwisefixingshallbeasforsurfa ceconduitson walls, drilled and tapped to the metalwork Power driven fixings shall only be used with the express permission of the Engineer. Any drilling or access which shall be required through any structural member of the building shall be agreed with the Engineer before carrying out the work.

Exposed threads and places where galvanizing has been damaged shall be cleaned and then painted withtwocoatsofanapprovedmetalliczinc-basedpaint.Thistreatmentshallbeappliedasthework proceeds.

(c) ConcealedInstallation

Concealedconduitsshallbesecurelyfixedtopreventmovement beforelayingofscreeds,floatingof plaster, casting of columns or other building operations necessary after the conduit installation. Crampetsorsimilarfixingsshallbeusedforattachingtheconduittobrickwork,etc.Buil dingnails shall not be accepted.

At least 15 mm cover shall be allowed for finishes over the conduit. Where this cover cannot be maintainedthenexpandedmetalshallbefittedwiththeconduit.Conduitcastintoreinfo rcedconcrete floors shall be fixed to the steel reinforcing with binding wire and the conduit boxes filled with expanded polystyrene or enclosed in a plastic bag to prevent the ingress of concrete when poured. Wherepossible,theconduitboxesshallbefixedtoshutteringtogiveaflush finish.

Conduitinstalledinvoids,falseceilings,andotherconcealedroutesshallbeinstalledas specifiedfor the surface conduits. Wiring shall be carried out after the false ceiling or permanent ducts have been completed. Conduit installed in floors shall be sealed against ingress of moisture.

TheconduitinstallationshallbeinspectedbytheEngineerbeforethebuildingoperatio nconcealsthe work.

CableInstalledinFlexibleConduit

Flexibleconduitshallbeofthewaterproofgalvanizedtypeor PVCwire-woundtypewithcadmium plated mild steel couplings. Lengths of flexible conduits shall be sufficient to permit withdrawal, adjustment or movement of the equipment to which it shall be attached and shall have a minimum length of 300 mm. Flexible conduit shall not be used as a means of providing earth continuity. A singleearthconductorofadequatesizeshallbeinstalledexternaltotheconduitcompl

etewithearth terminations.

Whereconversionfromrigidconduittoflexiblemetallicconduitshallbemade,therigid conduitshall terminate in a through type box and the flexible conduit shall extend from this box to the equipment, the earth continuity cable shall be secured to the box and to the piece of equipment by properly

designedearthingscrews.Theuseoflidfacingscrews,etc.shall not bepermitted.Adaptersshall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

CableInstalledinCableTrunking–Metal

Cabletrunkingshall bemanufacturedfrommildsteelofnot lessthan 125mmandshall behotdipped galvanized. The Contractor shall ensure that the size of the trunking shall be adequate for the number of cables to be installed together with 50% spare capacity and shall in any case be 50mm x 50 mm minimum size.

Segregationofcablesshallbecarriedoutifrequiredusingcontinuoussheetsteelbarrierswiththe bottom edge welded to the trunking.

The trunking shall have two return flanges for rigidity. Where necessary, additional strengthening straps shall be fitted internally. The cover shall overlap the trunking and be made of the same gauge. Fixingscrewsforcoversshallberecessedandbeoftheself-retaining`quickfix'type.All bends,tees and intersections shall be of the gusset type and shall, wherever possible, be purpose made by the manufacturer and of a matching design to the main trunking.

Cables shall be retained in the trunking when the cover shall be removed by means of straps. Internal connectingsleevesshallbefittedacrossjointsinthetrunkingandearthcontinuityensuredbybonding each section of trunking to a continuous earth wire.

Non-flammable fire barriers shall be inserted where the trunking passes through walls or floors. Conduitconnectionstotrunkingshallbemadebyflangedcouplingsandmalebushes.Trunkingshall be supported at intervals not greater than 2 m horizontally or 25 m vertically. Crossings over expansion joints shall be made in flexible conduit.

Shoulditbenecessarytocut ordrill asectionoftrunkingoratrunkingfitting thebaredendsshall immediately be given a coat of zinc rich cold galvanizing paint.

Cable and conduit / trunking runs shall be determined by the Contractor and agreed by the Engineer beforeanyworkshall bestarted.Therunshall beat least 150mmclearofplumbingandmechanical services. Conduit / trunking systems erected outside a building shall be weatherproof.

CableInstalledonCableTray

Cable tray shall be of perforated sheet steel with formed flanges and of minimum thickness not less than 1.5mm for trays up to 100mm width, perforated / ladder type with minimum thickness not less than2mmfortraysabove100mmto300mmwidthand2.5mmfortraysabove300mmwidth.Exterior perforated cable trays shall be covered with cable tray covers.

Cable tray shall be hot dipped galvanized. Cable tray for use in areas where

chlorine gas may be presentshallconstructfromU-PVCorGRPCabletraysupportsshallbeofacompatiblefinishwith the associated cable tray.

Allcabletraytees,intersectionunits,bends,turnsandsetsshall,wheneverpossible,be purposemade by the manufacturer and shall be of a matching design to the main section of cable tray.

Trayshall onlybejoinedbycouplerssuppliedbythemanufacturers.Thejointshallbesecuredin accordance with the manufacturer’s instructions.

Cable tray supports supplied by a manufacturer or made up on site shall be of ample strength to maintainrigidsupporttothefullyladencabletrayalongitsentirelengthandshallensur ethatthe deflection of any one section does not exceed 15 mm at mid-span.

Wherever possible, cable trays shall be installed in full lengths without cutting. Should it be necessary to cut or drill a length of tray, then for galvanized trays, the bared ends or damaged section of the tray shallimmediatelybegivenacoatofzincrichcoldgalvanizedpaint.Allsitemanufacture daccessories, supports and metal fittings required to ensure correct installation of the cable trays shall be similarly treated.

All cables shall be firmly secured to the tray using purpose made saddles, as approved by the Engineer, together with proprietary nylon fasteners and / or cable cleats. Following installation of cables, the tray shall remain rigidly supported and the deflection of any section shall not exceed 15 mmatmid-span.Allbracketsandtrayworkshallbesuitableforwithstandingatemporaryweighto f 125 kg.

Cabletraysshallnotbecuttoallowthepassageofcablesthroughthesurfacesofthetray .Thesizing of the cable tray shall provide a minimum of 25% spare capacity. The tray shall be run at least 150 mm clear of plumbing and mechanical services.

CableInstalledonLadderRack Systems

Ladderrackingeitherlightor heavyweight shallbe proprietaryitemand installedin accordance with manufacturer'sinstructions.Bendsintheinstallationshalltakeaccountoftheminimu mbendingradii ofcablestobeinstalled.Cablesshallbeclippedtotheladderrackusingclipsdesignedfor thesystem inuseandappropriatetothetypeandsize ofcableinstalled.Thesizingofthecableracksystemshall provide a minimum of 25% spare capacity. The ladder racking shall be run at least 150 mm clear of plumbing and mechanical services.

CableClippedDirect

Allcablehangers,clips,cleatsandsaddlesshallbeofanapprovedtypeandappropriat etothetype and size of cable installed. Their spacing shall be such as to ensure a neat appearance and prevent sagging of the cables at all times during their installed life.

CableInstalledinInternalFloor Trench

(a) InShallowtrenches(maximumdepth500mm)

Inshallowtrenchesusedforelectrical servicesonly,cablesmaybelaidinaneatandorderlymanner onthefloorofthetrench.Onelayeronlyshallbeallowed.Additionalcablesshallbeinstalledon the

wallsofthetrenchinanapprovedmanner.Herethetrenchshallbesharedbyotherservices,cables shall be installed on the walls of the trench in an approved manner.

(b) Allothertrenchesincludingwalkthroughserviceducts

Cabling shall be installed to the walls of the trench in an approved manner. Where other services are present the cables shall be segregated from them and wherever possible kept above 'cold' 'wet' services.Cablesshouldnotberun,ifatall possible,aboveor incloseproximityto'hot'services.The cabling shall be installed in such a manner as to allow access to the other services for normal maintenance without disturbance of the electrical installation.

CableTerminationsandJoints

(i) **PowerCableTerminations**

Powercablesshallbeterminatedinsuitableboxesarrangedforboltingtoswitchgear,motorstarters and motors. Coresshallhave either crimped lugs orsleeves to match eitherpost terminals or bolted clamp terminals.

Each cable entry into a terminating box shall be made through a suitable gland, which shall have provisionforsecuringthearmourwhereapplicable.Wheresinglecoreglandsarerequired,theseshall be ofthenon-magnetictype andtheassociatedbox bottomplate, wherethecorepasses through, shall not have a continuous magnetic path.

Adequateprovisionshallbemadetobondthecablearmouringtotheboxand/orswitchgearcasingof a suitable size to withstand the prospective short circuit fault current of the system, glands shall be fitted with earth bonding tags where intimate screwed contact between gland and cable box shall not be possible.

Wherecableglandsareexposedtotheweatherthenseshallbeprotectedbyheatshrinkplastic sleeveor purpose moulded sleeves covering the gland continuously from overall sheath to the gland neck.

Where terminations of multicore type have to be made on to items of plant which have to be dismantledformaintenance,theseshallbemadeoffthroughglandsintoanadaptableboxcontaining terminals and flexible single cores taken into the equipment via flexible waterproof plastic covered conduit, and a separate earth core linking the box to the equipment.

Wherecablesareglandedtoorpassedthroughcablingplatestheglandplateorcablingplate shallbe constructed of non-magnetic material.

(ii) **PowerCableJoints**

Through joints shall only be allowed with the approval of the Engineer. Where such joints are necessary in thermoplastic and elastomeric cables, the cables shall be jointed with epoxy or acrylic resin cold setting compound, which has been premeasured and pre-packed ready for use. The boxes shallpreferablybeofsplit,mouldedplastictypewithfillingventsforcompound.Bondingstrapsshallbe

fittedwitharmourclampsacrossthejointandinspectedbytheEngineerpriortofillingtheboxwith
compound.Wrappedpressuretypejointsshallnotbeaccepted.IncaseofHTcableendtermination and
straightthroughjointsshallbeapprovedheatshrinkabletype.Highvoltagetestshallbeconducted,and

testreportsandmegger valuesshallbesubmittedaftertestalongwithcalibrationcertificatesofthe instrument used for measuring.

(iii) **MulticoreorControlCable Terminations**

A sufficient number of terminals shall be provided to terminate all cable cores including 10% spare cores.Forcontrolandauxiliarywiringanadditional20%ofthisnumbershallbeprovide dasspares.

Notmorethanonecoreofinternalorexternalwiringshallbeconnectedonanyonetermi nal.Where duplication of terminal blocks are necessary, purpose-made solid links shall be incorporated in the design of the terminal blocks.

Terminalswhichremainenergizedwhenthemainequipmentshallbeisolatedshall besuitably screened and labelled.

Terminalblocksfordifferentvoltagesorcircuittypeshallbesegregatedintogroupsanddisti nctively labelled.

CableFixings

Tiesandstrappingshall besuitableforsecuringcableandcablegroupstocabletrayorladder.They shall be resistant to chemical and marine corrosion Plastic coated metal ties used in order to obtain corrosionresistanceshallnot beacceptable.Nylontiesshall beresistanttotheeffectsofultra-violet lightandshallbeself-extinguishing.Largesinglecablesshallbesecuredwithcableclampsorcable cleats.

CableIdentification

At each end of each cable, in a uniform and visible position a label shall be fixed on the cable in accordancewiththecableschedule.LabelsshallbemadeofPVCandshallbeindelibly markedtothe approval of the Engineer. The label shall be retained using proprietary nylon strips passing through two fixing holes at either end of the label. If the cable gland shall not be normally visible, then the label shall be fixed inside the panel by means of screws.

CableGlands

Glands shall generally be of the mechanical double compression hexagon type Earth continuity of brassglandsshallconfirmtoBS:6121/ EN50262.Thismaybeachievedbytherigidclampingofthe armour within the gland and the intimate contact between the threaded components of the gland and the equipment.

Each gland shall be installed complete with proprietary earth tag providing a ready means of connectingaflexiblestrandorstripearthbondtotheglandat anypositionaroundtheglandinrelation totheassociatedapparatus.Adequateearthcontinuityshallbeassuredbetweentheea

rthtag,thegland and the armour wires of the cable where applicable.

Glandsforsinglecorecablesshallbeconstructedfromnon-magneticmaterials.Eachglandshallbe installedcompletewithaproprietarynon-ferrouslocknuttosecuretheglandbodytothe equipment

wheretheentryholeisplain,i.e.,nottapped.Whereholesforcableentriesarenotprovid editshallbe the responsibilityof the contractor to markout and drill such holes Burrs and swarf shall be removed, care being taken to ensure that swarf and filings, etc do not enter the equipment.

Fornon-hazardousareascableglandsinsituationswheremoisturemaybepresentshallbedoub leseal weatherproof type, gland shrouds shall be used, and entry shall be sealed. For dry indoor situations, standard industrial glands with shrouds are acceptable. For hazardous areas, glands conforming to EExd standard shall be used with double seal and shroud.

Powercableglandingarrangementsinhazardousareasshallincorporateaninsulated adapterandearth link.Thisshall providethefacilitytodisconnectthearmouringfromtheglandeddeviceinorderthat a true earth loop value may be measured when carrying out tests on the installation. Cable Glands shall be suitable for indoor and outdoor use, appropriate for single wire armoured, plastic or rubbersheathed cable. Which provides grip to the cable with outer and inner seals suitable for all climatic conditions weatherproof and waterproof. The outdoor cable glands shall be provided with shrouding.

MarkingLocationsofUndergroundCables

Thelocationofallundergroundcablesshallbeengravedonbrassorothernon-corrodibleplatestobe fixed to the exterior surface of all walls of buildings 300 mm above ground level and directly above the point where cables pass through the wall.

In addition, concrete route marker posts shall be installed at intervals of not more than 50 m at all junctions and changes of direction along the cable route and cable joint markers shall be provided whereverundergroundingcablejointexists.Suchmarkerpostsshallbenotlessthan20 0mmhighand of substantial construction.

Adrawingorsampleofatypical marker post shall besubmittedfortheapprovaloftheEngineer.The markers shall be marked ‘electric cable’ / ‘cable Joint’ in English and the vernacular.

DrawingsandData

All Drawings, data,technical particulars,calculations,detailed literature,catalogues, testcertificates etc,shallbesubmittedalongwiththebid/afterawardofcontractasspecifiedunder,“B id/Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

CableCarrier System

General

Thecablecarriersystemcoversthesupplyofcableracks,cabletraysanditssupportingacces
sories.

ApplicableStandards

Steelforgeneralstructuralpurposes
: IS:2062

Dimensionsforhotrolledsteelbeam : IS:808

columnchannelandanglesections

Codeofpracticeforuseofmetal arc : IS:816

weldingforgeneralconstructioninmildsteel

Hotdeepgalvanizingofiron& steel : IS:2629

Methodsoftestinguniformityofcoating : IS:2633

ofzinccoated articles

onstructuralHotdipzinccoatings : IS:4759

steelandotherallied products

CableRacks,Traysandtheirsupport structure

(a) Cableracks/traysshallbefabricatedfromstandardstructuralsteelmembers.

(b) All cable trays, vertical raceways, cable racks and cable tray supporting structures shall be hot dip galvanized.

Galvanising

Wherever galvanizing has been specified, the hot dip process shall be used. The galvanized coating shallbeofuniformthickness.WeightofZinccoatingsforvariousapplicationsshallnot belessthan those indicated below:

(a)Fabricated Steel

Thicknesslessthan2mm,butnotlessthan12mm	340 gms/sqm
Thickness less than 5 mm, but not less than 2 mm Thickness 5 mm and over	460 gms/sqm
	610 gms/sqm

(b) Fasteners

UptonominalsizeM10	270 gms/sqm
OverM10	300 gms/sqm

Galvanizing shall be carried out after all drilling, punching, cutting, bending and welding operations havebeencarriedout.Burrsshallberemovedbeforegalvanizing.Anysitemodification ofgalvanized parts such welded joints, fabricated cable trays and supports should be covered well by zinc rich primer and aluminium paint.

DrawingsandData

AllDrawings,data,technicalparticulars,calculations,detailedliterature,catalogues,testcertificates etcshall besubmittedalongwiththebid/ afterawardofcontractasspecifiedunder,“Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

Lighting System

GeneralRequirements

LEDlightingshallbeconsideredforindoorandoutdoorlighting.TheLightingsystemincludesthe following items

(i) LightingfixturescompletewithLampsandaccessories(lumenperwattshallbeindicated).
(ii) Lightingsystemequipment(ISImake).
- Lightcontrolswitches,receptacleunitswithcontrol.
- Switch units, lighting wires, conduits and other similar items necessary to completelighting system.
- Lightingfixturesupports,streetlightingpolesandfloodlighttowers.
- MainLightingdistributionboard,lightingpanels.
- Multicorecablesforstreet,boundaryandfloodlighting.

LEDRequirements

- High Power White LEDs are used in the luminaries and the Wattage of these LEDs would begreater than ONE watt.
- LEDshallbeoperatedataforwardcurrentoflessthan90%oftherated current.
- ColourRenderingIndex(CRI)oftheLEDsusedintheluminaireshallbegreaterthan70.
- The illumination of the luminaries shall be uniform without dark bands or abrupt variations and soothing to the eye.
- Light Uniformity Ratio (E_{min}/ E_{avg}) shall be as per National Lighting Code, National building Code.
- LuminaryBodyTemperaturewouldbelessthan30degCabovetheambient,evenafter continuous burning of Luminary for 24 Hrs.
- TheLuminaireworksonsinglephasethreewiresystem(Phase,Neutral&Earth).

ConstructionofLEDluminaires

(a) The luminaire housing shall be made up of Corrosion free High Pressure Aluminium die cast thus confirming the luminaire to IP-65 protection and safety as per IEC 60598-1.
(b) The Luminaire shall be equipped with distortion free, clear, Heat Resistant toughened, UV stabilized glass cover in the front fixed to the die cast Aluminium frame which would be fixedto the housing by means of stainless-steel screws.

TheminimumtechnicalspecificationsforLEDlightingshallbeasfollows:

(i) PoweredbythelatestbrightLEDswithhighefficiencyandmeetingLM-80 standard.
(ii) Averageratedlifespanof50000hrs.
(iii) LEDlumenoutputshallbegreaterthan125Lumens/ watt.
(iv) Luminaries'lumenoutputofatleast80Lumens/watt.
(v) Inputvoltagerange90-300V.
(vi) Powerfactor>09.
(vii) THD<15%.
(viii) IngressprotectionasperIP65.
(ix) Operatingtemperature: -5°Cto50°C.
(x) Storagetemperature:-5°to70°C.
(xi) Humidity10%-100%.
(xii) LEDsshallbeoperatedataforwardcurrentlessthan90%ofitsrated current.
(xiii) TheLEDsusedintheluminaireshallhaveminimumangleof120degree.
(xiv) Colourrenderingindex(CRI)oftheLEDsshallbegreaterthan70.
(xv) ConformtoPhotoBiologicalSafetyfortheLEDsasperIEC62471.
(xvi) Freereplacementwarrantiesof5yearsfortechnicaldefects.

Applicablecodes&standards

Tests

Contractorshallsubmitallfollowingtestreportsfor LEDlighting fixturesbeforedispatchingof material at site. All tests shall be carried as per IES approved methods defined (LM-82)

(a) LM-80formeasurementoflumenofLEDsource.
(b) LM-79forfixture-Electrical&Photometricmeasurement.
(c) TM-21testforLEDlife.
(d) ThermalCharacteristic-TestforLumenoutputtemperaturedependency.
(e) ElectricalCharacteristic -Testforthecalculationof efficacy.
(f) DrivertestingforPowerfactor,THD&Isolation.
(g) IPProtectiontestagainstingressofduct&solidobjectsforbothindoor&outdoorLED fixtures.

Earthing

(i) Eachluminaireshallbeprovidedwithanearthingterminalsuitableforconnection tothe earthing conductor of 12 SWG GI wire.

(ii) Where separate control gear box shall be provided for housing the accessories the same shall be provided with an earthing terminal suitable for connecting earthing conductor of 12 SWG GI wire.
(iii) All metal or metal enclosed parts of the luminaire / control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.

Painting/ Finish

(i) All surfaces of the Luminaire / Control gear box housing accessories shall be thoroughlycleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.
(ii) When enamel finish shall be specified, it shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading.
(iii) The luminaire housing shall be stove-enamelled / epoxy stove-enamelled-vitreous enamelled or anodized as indicated under various types of fittings.
(iv) The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg over 1/2” dia mandrel.
(v) The finish of the luminaire shall be such that no bright spots are produced either by direct light source or by reflection. External control gear box provided for housing accessories shall be painted or galvanized.

ApplicableStandards

Alllightfittingsshallbeenergyefficienttypewithlumenperwattshallbespecified. Thedesign, manufactureandperformanceofequipmentshallconformtothelateststandardsspecifiedbelow:

NationalLightingCode :SP 72

NationalBuildingCode :SP 7 - 2016

NationalElectricCode :SP30 - 2023

Codeofpracticeforindustriallighting :IS6665

Code of Practice for Interior Illumination :IS364

6 2006 / 95 / EC, Low Voltage Directive (LVD).

2004/108 /EC, EMCDirective.

Codeofpracticeforlightingofpublic thoroughfare :IS1944(Part 1&2)

Light and lighting. Lighting of workplaces :BSEN12464par

t1 Indoor workplaces

Lightandlighting.Lightingofworkplaces : BSEN12464part2

Outdoorworkplaces

EN50530,IEC62124,IEC61347-2-13, IEC62384,CISPR15,IEC61547,IEC60598

Electrical lighting fittings general and : IS:1913/ BS:4533

safetyrequirements

Calculation of co-efficient of utilization : IS:3646(Part-

III) Industrial lighting fittings with metal : IS:1777

Reflectors

Decorativelightingoutfits : IS:5077

Dustproofelectriclightingfittings : IS:4012

Dusttightelectriclightingfittings : IS:4013

Flood lights : IS:10322/BS:4533

Luminairesforstreetlighting : IS:10322Part5

Watertightelectriclightingfittings : IS:3553/ BS:4533,5225(I)

Bayonetlampholders : IS:1258/ BSEN 61184/IEC:60061

Edisonscrewlamp holders : IS:10276/BSEN 60238

Bi-Pinlampholdersfortubularfluorescentlamps : IS:3323

Startersforfluorescentlamp : IS:2215/ BSEN60155

Holders for starters for tubular fluorescent lamps : IS:3324/BSEN60400 Ballast for use in fluorescent

lighting fittings : IS:1534 (Part1)/BSEN60920&60921

Transistorizedballastforfluorescentlamps : IS:7027

BallastforHPmercuryvapourlamp : IS:6616

Capacitors for use in fluorescent lamps : IS:1569/

BSEN 61048

HPMV & LP sodium vapour discharge circuits & 61049 /

IEC:60586 Vitreous enamel reflector for tungsten :

IS:8017 filament

lamp

Tubularfluorescentlamps
: IS:2418(Part –1)/BSEN 60081

IEC:60081

Highpressuremercuryvapourlamps : IS:990
BS:3677 / IEC:60188 0/

TungstenfilamentGeneralElectricla : IS:418/
mps IEC:60432

CastacrylicsheetsforuseinLuminaires : IS:75
69

Screwlessterminalandelectrical :
IS:10322

connectionsforlightingfittings

Highpressuresodiumvapourlamps :
IS:9974

Emergencylightingunits
: IS:9583

Ignition proof enclosures, dust-tight for :

IS:11005

elect Equipment

Luminaires
: IS:10322(PartItoV)

LightingSystemEquipment

Arrangement for busbars, main connections :
IS:5578/11353/

BS:159

andauxiliarywiringand marking

Enclosed distribution fuse boards and : IS:2675/ BSEN 60439

Cut-outsforvoltagesnotexceeding1000V

General requirements for switchgear and : IS:13947

Control gear for voltages not exceeding 1000V

Codeofpractice-installationand : IS:10118/ BS:6423

Maintenanceofswitchgear : BS6626,BS6867

Factory built assemblies of switchgear : IS:8623/ BS-5486 / IEC:60439

andcontrolgearforvoltagesuptoand Including1000 V AC and 1200 V DC

Miniature air break circuit breakers for : IS:8828/ BSEN 60898

ACcircuits

HRC cartridge fuse links up to 650 V : IS:9224/ BS:88 / IEC:60269

Currenttransformers :IS:16227(Part2):2016/IEC61869-2:2012

Voltagetransformers :IS:3156/ BS:7625/ IEC:60186

Direct acting electrical indicating Instruments : IS:1248/BS:89/ IEC:60051

ACelectricitymeters :IS:722 / BS 5685

Electrical relays for power system protection : IS:3231/BS:142/ IEC:60255

Switches for domestic and similar purposes :

IS:3854/BS:3676

Three pin plugs and socket outlets :

IS:1293/ BS:546

Boxesforenclosureofelectrical accessories	:	IS:5133(1)
Rigidsteelconduitsforelectrical wiring	:	IS:9537/ BS:31
Accessoriesforrigidsteelconduitsfor BS-31	:	IS:3837/
electricalwiring		
Flexiblesteelconduitsforelectricalwiring	:	IS:3480
Rigidnon-metallicconduitsforelectrical BS:4607(2)	:	IS:9537/
Installations		
Fittingsforrigidnon-metallicconduits BS:4607(2)	:	IS:3419/
PVCinsulatedcablesforworkingvoltages	:	IS:694
Uptoandincluding1100V		
Tubularsteelpoles	:	IS:2713
Specificationforcopperrodsandbars	:	IS:613
Code of practice for phosphate coated iron	:	IS:6005/
BS:3189		
and steel		
Fittingsforrigidsteelconduitsfor	:	14768:Part2
electricalwiring		

LightingFixtures(Luminaires-LED)

(a) Luminairesshall bedesigned forcontinuoustrouble-free operation withoutreductioninlamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather- proof and rain-proof type.

(b) The Luminaires shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps / starters etc.

(c) Connections between different components shall be made in such a way that they shall not work loose by small vibration.

(d) For each type of Luminaires, the Contractor shall furnish the utilisation factor tables to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.

(e) All Luminaires shall be supplied complete with lamps suitable for operation on a supply voltagewiththevariationinsupplyvoltage,frequencyandcombinedvoltageandfrequencyof
± 10%,± 5%and± 10% respectively.

DecorativeLuminaires(Luminaires-LED)

(a) These luminaires shall be generally indoor type provided with cold rolled cold annealed(CRCA) sheet steel channel / rail cum reflector housing complete with all electrical control accessories mounted on it. The finish shall be stove enamelled.
(b) Decorative LED type luminaires shall be either open type, provided with translucent white opal acrylic diffusers, polystyrene lens prismatic or square polystyrene louvers
(c) Luminaires shall be suitable for the number of lamps of specified wattage, direct mounting on ceiling / wall / column pendant mounting or for recess mounting in false ceiling.
(d) Decorative luminaires with mirror optic reflectors shall be of the wide-angle dispersion type. Where these luminaires are mounted in control rooms and computer rooms, clip-on type adjustable reflectors which can be attached onto the tube shall be provided to direct the light output in the desired direction. This shall be mainly to reduce reflection of the light source from TV / monitor screens.
(e) Luminaires mounted recessed in false ceiling shall be with reflector housing and spring-loaded fixingarrangement forthediffuser/ louver frame. It shall bepossibleto have accesstothelamp and other accessories from below.

IndustrialLuminaires(Luminaires-LED)

(a) The luminaire shall be provided with CRCA sheet steel mounting rail with reflector ofminimum 20 SWG thicknesses and complete with all control accessories mounted on it. The finish shall be vitreous enamelled.
(b) Luminaires shall be suitable for the number of lamps of specified wattage, direct mounting on ceiling / wall / column / pendent mounting.
(c) The distribution of light shall be such that at least 80% of the total luminous flux from the luminaire shall be in the lower hemisphere.
(d) The luminous output of the luminaire with reflector shall not be less than 75% irrespective of type of reflector used

BulkheadLED Luminaire

(a) The luminaire shall be of robust construction, with cast aluminium / vitreous enamelled housing, heat and shock resistant prismatic or clear glass cover fixed with neoprene gaskets for sealing. For mechanical protection to the glass cover, round steel wire-guard with vitreous enamelled finish shall be provided
(b) The luminaire shall be suitable for direct mounting to ceiling / wall / column and used for general purpose indoor lighting.

High,MediumandLowBayLEDLuminaires

(a) High and mediumbayluminaires shall be withcast aluminiumhousing, anodizedaluminium mirror polished reflector canopy with eye bolt for suspension, cooling fins and glass cover.

(b) The luminaire shall be suitable for up to 400 / 1000 watts LED lamps. The control gear accessories shall be mounted integral with the luminaire.

(c) High bay luminaires shall be used when the mounting height is above 8 meters whilemedium bay luminaires shall be used when the mounting height is around 6 to 8 meters.

FloodLightLED Luminaire

Floodlightluminairesshallbeofweatherproofconstructionwithcastaluminiumhousing,anodized aluminium mirror polished reflector, heat resistant, toughened glass cover and necessary neoprene gaskets to prevent ingress of dust

(a) The housing shall be supported on a cast iron base and capable of being swivelled in both horizontal and vertical directions and locked in any desired position.

(b) For focusing purposes, knobs, shall be provided along with sector plate indicating the angle in degrees between 0 and 90 deg in vertical direction.

OutdoorLanternLEDLuminaires

(a) Post top lantern Luminaires shall be generally outdoor weatherproof type for illumination of walkways, gate posts, gardens etc

(b) The luminaire shall have cast aluminium spigot of 50 / 60 diameter finished with corrosion proof paint for mounting, opal acrylic or high-density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.

Sub-stationLantern

(a) Sub-station lantern shall be generally outdoor weatherproof type for illumination of switchyard equipment.

(b) The luminaire shall have cast aluminium housing finished with corrosion proof paint, spigot for mounting on pole, prismatic glass refractor dome to give distribution of light in horizontal plane, anodized aluminium reflector to give light distribution at an angle 20 to 40 degrees,above the horizontal plane, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.

StreetLightingLuminaires

(a) Street lighting LED luminaire shall be outdoor weatherproof type for illumination of secondary roads, walkways, peripheral lighting of buildings etc.

(b) The luminaire shall be of semi-cut off or non-cut off type, with CRCA sheet steel housing, vitreous enamelled, plain or corrugated clear acrylic cover, complete with integral mounted control gear, neoprene gaskets, side pipe entry or top suspension type.

(c) The luminaire shall be of semi-cut off with cast aluminium housing, acrylic or prismatic cover, polished aluminium reflectors, complete with integral mounted control gear, neoprene gaskets and with rear pipe entry.

(d) TheContractor shallprovidestreet lightingsystemstoilluminateall siteroadwayswithinthe treatment facility areas and access road. Lux level for outdoor site shall be as per IS 1944. Outdoor lighting shall cover the perimeter portion also to focus CCTV camera at 20 Lux level.

(e) Thelanterns shall incorporate LEDlamps with integral lamp control gear, and weather-proof body.

(f) The poles shall be sited a minimum of 1m from the road kerb edge with non-extended brackets to locate the lanterns at the kerb.

(g) The street lighting shall be fed on independent radial buried cable circuits fed and controlled from a street lighting switchboard. The cables laid for outdoor lighting application shall be wire armoured.

(h) Each circuit shall be contactor switched, controlled by an astronomical timer and manual - auto control selector switch. The contactor, time switch and manual control switch for each area shall be incorporated in the LV road lighting distribution switchboard.

PortableEmergencyLightLuminaire

(a) Emergency light of installed luminaire shall be indoor type for providing emergency light during failure of normal AC supply.

(b) The luminaire shall be with CRCA sheet steel enclosure, complete with metalized mirror reflector, leak proof re-chargeable battery rated for two-hour discharge, battery charger,charger-on lamp, push button switches, automatic changeover switch / relay, two meter length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminaire.

(c) The luminaire shall be suitable for connection to 240 V, 50 Hz single phase supply. On failure of normal AC supply the luminaire shall pick-up automatically and on restoration of AC supply the luminaire shall switch off automatically.

(d) Theluminaireshallbesuitableforenergyefficiency LEDlamps.

AccessoriesforLumi

naires Reflectors

(a) The reflectors shall be made of CRCA sheet steel / aluminium / silvered glass / chromium plated sheet copper as indicated for above mentioned luminaires.

(b) The thickness of steel / aluminium shall comply with relevant standards. Reflectors made of steel shall have vitreous enamelled finish. Aluminium used for reflectors shall be anodized / epoxy stove enamelled / mirror polished. The finish for the reflector shall be as indicated for above mentioned fittings.

(c) Reflectors shall be free fromscratches or blisters and shall have a smooth and glossy surface having an optimum light reflecting coefficient so as to ensure the overall light output specified by the Contractor.

(d) Reflectorsshallbereadilyremovablefromthehousingforcleaningand maintenancewithout disturbingthelamps and without theuse of tools. Theyshall be securelyfixedto the housingby means of positive fastening device of captive type.

Lampholders/StarterHolders

(a) Lamp holders shall have low contact resistance, shall be resistant to wear and shall be suitableforoperationatthespecifiedtemperaturewithoutdeteriorationininsulationvalue.

They shall hold the lamps in position under normal condition of shock and vibration met with under normal installation and use.

(b) Lamp holders for the fluorescent lamps shall be of the spring loaded bi-pin rotor type. Live parts of the lamp's holder shall not be exposed during insertion or removal of lamp or after the lamp has been taken out. The lamp holder contacts shall provide adequate pressure on the lamp cap pins when the lamp shall be in working position.

(c) Lamp holders for induction, mercury vapour and sodium vapour lamps shall be of Edison Screw (ES) type.

(d) The starter holders shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.

Controlswitchgearelectronicballasts

(a) The ballasts shall be designed to have a long service life and low power loss. The ballasts shall be of the inductive, heavy duty type copper wire wound, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. Ballastsshall be provided withtapsto set thevoltage within therange of variationin supplyvoltage of± 10% of 240 V End connections and taps shall be brought out to a suitable terminal blockrigidly fixed to the ballast enclosure. Ballasts shall be free from hum and such of those which produce hum shall be replaced by Contractor free of cost.

(b) Ballasts shall be mounted using self-locking, anti-vibration fixings and shall be easy to remove without demounting the fittings. They shall be in dust tight, non-combustibleenclosures.

(c) Separate ballast for each lamp shall be provided in case of multi lamp luminaires, except in the case of 2 x 20 Watts luminaires.

Starters/ Igniters

(a) Starters shall have bimetal electrodes / electronic igniters and high mechanical strength. Starters shall bereplaceable without disturbingthereflector or lamps and withoutthe use of any tool Starters shall have brass contacts and radio interference capacitors.

Capacitors

(a) The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

(b) The capacitors shall be suitable for operation at specified supply voltage conditions and shall haveavalueofcapacitancesoastocorrectthepowerfactoroftheircorrespondingl ampscircuit to the extent of 095 lag or better.

(c) The capacitors shall be hermetically sealed preferably in a metal enclosure to preventseepage of impregnate and ingress of moisture.

GalvanizedOctagonalPolesforStreet Lighting

The Octagonal poles shall be designed to withstand the maximum wind speed of 169 KM / Hr. as per IS875.Thetoploadingi.e.,areaandtheweightoffixturesaretobeconsideredtocalculatemaximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI.

(a) PoleShaft

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinalwelding.Thereshallnotbeanycircumferentialwelding.Theweldingofpoleshaftshall be done by submerged Arc Welding (SAW) process.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provisionforfixing4foundationbolts.Thisbaseplateshallbefilletweldedtothepoleshaftattwo locations i.e., from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

(b) Door opening

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from theBaseplate.Thedoorshallbevandal resistanceandshall beweatherprooftoensuresafetyofinside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

Thepoleshallbeadequatelystrengthenedatthelocationofthedoortocompensatefortheloss in section.

(c) Material

OctagonalPoles	:	HTSteelConformingtogradeS355JO
Base Plate	:	Fe410conformingtoIS226/IS2062
Foundation Bolts	:	EN8 grade

(d) Welding

Theweldingshallbecarriedoutconfirmingtoapprovedproceduresdulyqualifiedbythirdparty inspection agency. The welders shall also be qualified for welding the octagonal shafts.

(e) Polesections

TheOctagonalPolesshallbeinsinglesection(upto11mtr)Thereshallnotbeanycircumferential weld joint.

(f) Galvanization

ThepolesshallbehotdipgalvanizedasperIS2629/IS2633/ IS4759standardswithaverage coating thickness of 100 micron the

galvanizing shall be done in single dipping.

(g) Xingtype

TheOctagonalPolesshallbeboltedonapre-castfoundationwithasetoffourfoundationboltsfor greater rigidity.

(h) TopMountings

Thegalvanizedmountingbracketshallbesuppliedalongwiththe OctagonalPolesforInstallationof the luminaries.

(i) Manufacturing

Thepolemanufacturing&galvanizingunitshallbeISO9001:2000&ISO14001certifiedtoensure consistent quality & environmental protection.

(j) Servicewindow

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow accesstoelectricalconnectionsandterminations.ItshallbecoveredwithGIplateandproperrubber gaskets shall be provided to prevent any ingress of water etc.

(k) Electricalconnections

Four-wayconnectors shallbe provided alongwith Slide lock and1 no. 6amps SP MCBincluding2.5 sq.mmPVCinsulatedcopperconductorwiresfromtheterminalblocktothefixtureand2 nos.32mm dia. GI sleeves of suitable length shall be provided up to the service window. An earth boss shall be provided on the control plate along with connectors and interrupters.

DrawingsandData

AllDrawings,data,technicalparticulars,calculations,detailedliterature,catalogues,testcertificates etc shall be submitted alongwiththe bid/ after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

LightingSystemEquipment

MainLightingDistributionBoardandLightingPanels(ACPhasesegregated&DC)

(a) ConstructionalFeatures

(i) Boards and panels shall be sheet steel enclosed and shall be fully dust and vermin proof, providing a degree of protection of IP 52 for indoor. Outdoor panels shall in addition be completely weather-proof with a sloping canopy for protection against rain and providing a degree of protection of IP 55. The sheet steel used for frame, frame enclosures, doors, covers and partitions shall be cold rolled 2 mm thick.

(ii) All boards and panels shall be provided with hinged doors for access to equipment. Doors shall be gasketed all round with neoprene gaskets. For the main floor mounted distribution boards with the MCB arranged in tier formation, the hinged door of each unit shall be interlocked so as to prevent opening of the door when the switch shall be ON and to prevent closing of the switch with the door not fully closed. However, a device for by-passing the door interlock shall be provided to enable the operation of the switch with the door open, when necessary, for examination / maintenance. For wall mounting 1-phase ways lighting panelswhen provided with MCBs, a hinged, latched front door shall be provided with

key-locking facility and a slotted Bakelite sheet shall be provided inside. Only the MCBs operating knobs or the fuse cap covers shall project out of the Bakelite sheet slots for safe operation and neat appearance Incomer to lighting panels shall be provided with TPN MCCB with RCD.

(iii) All accessible live connections / metals shall be shrouded, and it shall be possible to change individualfuses,switches,MCBsfromthefrontoftheboards/panelswithoutdangerofcontact with live metal.

(iv) For floor mounting type distribution boards, adequately sized mounting channels shall be supplied and for wall / column / structure mounting type panels suitable mounting straps shallbe provided.

(v) Adequate interior cabling space and suitable removable cable entry plates shall be provided for top / bottom entry of cables through glands and or conduits as required. Necessary numberof glands to suit the specified cable sizes shall be provided. Cable glands shall be screwed on type and made of brass.

(vi) Twoearthingterminalsshallbeprovidedtosuittheearthingconductor

(vii) All sheet steel parts shall undergo rust-proofing process which should include degreasing,de-scaling and a recognized phosphate process. The steel works shall then be painted with two coats of Zinc - chromate primer and two coats of final stove-enamelled finish paint of specified colour.

(b) Busbars

(i) Busbarsshallbeofcopperconductorofharddrawn(HD)andhighconductivity. Allbusbars shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi.

(ii) Busbars shall be provided with at least the minimum clearances in air as per applicable standards for 500 V, 3 phase system.

(iii) Busbars shall be adequately sized for the continuous current rating such that the maximum temperature of the busbars, busbar risers / droppers and contacts does not exceed 85° C under site reference ambient temperature.

(iv) The busbars, busbar connections and busbar support shall have sufficient strength to withstand thermal and electro-mechanical stresses of the fuse / MCB's let through / cut-off current associated with the specified short-circuit level of the system.

(v) Busbar supports shall be made from suitable insulating material such as Hylam sheets, glass reinforced moulded plastic materials, permali wood or cast resin. Separate supports shall be provided for each phase of the busbars. If a common support shall be provided for all three phases, anti-tracking barriers shall be incorporated.

(vi) The neutral bus of the main 3 phase, 4 wire distribution board shall be rated not less than50% of the phase busbars.The neutral bus of the 1 phase ways lighting panel shall be rated sameasthephasebusbars.Theneutralbusshouldhavesufficientterminalsanddetachablelinks for full number of single-phase outgoing lighting circuits.

Panels/Boards'Component Equipment

(a) MiniatureCircuitBreakers(MCB)/RCD

(i) MCBs shall be hand operated, air break, quick make, quick break type conforming to applicable standards

(ii) The switch shall be protected by fuse and the MCB shall be provided

with overload / short- circuit protective device for protection under overload and short-circuit conditions. The minimum breaking capacity of MCBs shall be 10kA rms at 415V / 220V DC.

(iii) Switch shall have provision for locking in both fully open and closed positions. MCBs shall be provided with locking facility

(iv) The incomer shall be MCCB for ≥ 63A and shall be MCB TPN for < 63A connections shall be phase segregated shall be insulated and all live connections shall be shrouded RCD with suitable rating shall be provided for incomer 100mA and power receptacle feeder 30mA One digital type energy meter shall be provided on each lighting MCB DB.

(b) Fusesfor DC

(i) Fuse less system shall be preferable however some special case fuses can be used. Fuses generally shall be of the HRC cartridge fuse-link type having a certified rupturing capacity of 80kA at 440V. Fuses up to 63A for distribution systems of medium short circuit levels may be of HRC linktype, having a certified rupturingcapacityof not less than 46kA at 440V and 16kA at 250V DC.

(ii) Fusesshallbeprovidedwithvisibleindicationtoshowthattheyhave operated.

(iii) Insulatedfusepullinghandleshall beprovidedforeachsizeoffuseforeachswitchboard.

(c) IndicatingInstrumentsandMeters(Digital)

(i) Whenever required, digital instruments and meters shall be of the flush mounting type They shall be suitably mounted so as to provide for easy access to CTs and small wiring.

(ii) Instrumentssuchasvoltmeterandammetershallbeofdigitalinstruments.

(iii) Watt-hourmetersshallbeofdirectreadingofdigitalmultifunctionmeter.

(d) InstrumentTransformers

(i) Current and voltage transformers shall be of the dry type, of metering accuracy class 1.0 unless otherwise specified, it shall be the responsibility of the Contractor to ensure that the VA burden of the instrument transformer shall be adequate for the meters connected to it.

(ii) Testlinksshall beprovidedinbothsecondaryleadsoftheCTstoeasilycarryoutcurrentand phase angle measurement tests. Facilities shall be provided for short-circuiting and grounding the CTs at the terminal blocks.

(iii) Voltagetransformersshallbeprovidedwithsuitablyratedprimaryandsecondaryfuses.

(e) Indicating Lights: Indicating lights shall be of the clustered LED type with translucentcovers.

(f) InternalWiring.

(i) Panels / boards shall be supplied completely wired, ready for the external connections at the terminal blocks. Wiring shall be carried out with 650 / 1100V grade, PVC insulated, stranded copper conductors of adequate sizes shall be used to suit the rated circuit current.

(ii) Engraved identification ferrules marked to correspondwith the wiringdiagramshall be fitted at both ends of each wire.

(iii) All wiring shall be terminated on terminal blocks. Terminal blocks shall be one piece moulded rated 500 V of reputed make, preferably stud type for higher current ratings such that wires are connected by cable-lugs and

complete with nuts and washers. Terminals shall be adequately rated for the circuit current; the minimum rating shall be 20A.

(iv) Terminalsforcircuitswithvoltageexceeding125Vshallbe shrouded.

(v) Terminals shall be numbered and provided with identification strip for identification of the circuit.

(vi) Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting / earthing facilities.

Labels&Diagram Plate

(a) All door mounted equipment as well as equipment mounted inside the switchboard / panels shall be provided with individual labels with equipment designation / rating. Also, the boards / panels shall be provided on the front with a label engraved with the designation of the board / panel.

(b) Labelsshallbemadeofnon-rustingmetal,3-plylamicoidorengravedPVC.

(c) Inside the door of the 1 phase ways lighting panels a circuit diagram / description shall be fixed for reference and identification.

LightControlboxand switches

(a) Light control switches of ratings and types, i.e., decorative / industrial shall be supplied as required. The switches shall be Modular suitable for use on 240V, 1Ph, 50Hz supply.

(b) Switches shall be of flush type for mounting behind an insulated modular plate or incorporated with a switch plate for mounting flush with the surface of wall or switch box / suitable enclosure. The modular switch box / enclosure may be recessed into or mounted on a wall as per the requirement of project layouts.

(c) Thesizeofenclosuremodularboxesshallbechosentoaccommodatethenumberofswitches to be installed at the particular location. The enclosures shall be 18-gauge sheet steelgalvanized. The enclosure plates / boxes shall be fabricated out of quality tested raw material such as metal, PVC, power coated metal. An enclosure intended for surface mounting shall not have holes or gaps in its sides other than those expressly provided for cable entry.

ReceptacleUnits

(a) Receptacle units shall consist of socket outlet with associated switch and plug. The socket outlet and switch (5/6A) or MCB (15/16A) shall be flush mounted within galvanized 18-gauge steel / modular enclosure with insulation cover. The box may be recessed into or mounted on a wall as per requirements of project layouts.

(b) The receptacle units shall be suitable for 240V, 1ph - N, 50Hz, 5 / 6A / 415V, 3Ph – N,50Hz, 15 / 16A supply as required.

(c) Single phase receptacles 15 / 16A shall be associated with ELCB and MCB of same current rating and the receptacle shall become live only when the associated ELCB and MCB shall bein “ON” position.

(d) Three phase receptacles shall be metal clad associated with a TPN MCB housed in the same enclosure. The receptacle shall become live only when the associated MCB switch shall be in “ON” position.

(e) The plugs shall be provided along with three phase receptacle with cord grips to prevent strain and damage to conductors / wires at connection and entry points.

LightingWires

(a) The wires for wiring in lighting system shall be 1100-volt grade ISI make, 1C, PVC insulated, un-armoured with stranded copper conductors.

(b) The minimum area of conductors shall be 15 sq.mm for light fittings and 5/6A Receptacles and 25 sq.mm for receptacles rated 15 / 16 A and above.

(c) The wires shall be coded white for phase/positive of DC and black for neutral / negative of DC.

Conduits

(a) Rigid non-metallic conduits and their associated fittings as required shall conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm for concealed installation.

(b) Non-metallic conduits shall be supplied in standard lengths of 5 m of 25 mm thickness and shall conform to IS 9537: Part 3.

(c) Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting system installation work inclusive of all the consumables such as adhesive tape / paste, rawal plug, screws etc.

JunctionBoxes

(a) Square or rectangular type modular Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for indoor / outdoor areas, 3 phase receptacles etc.

(b) Thejunction boxes shall be dust and vermin proof and shall be fabricated from quality tested raw material such as metal, PVC and powder coated metal and shall be complete withremovable cover plate with gaskets. Boxes shall be additionally weatherproof with earthing terminals.

(c) The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable / conduit entry knock outs, terminal blocks, earthing terminals as required.

(d) The terminal blocks, with specified number of terminals, shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 600 V, grade, one piece construction complete with terminals, insulation barriers, galvanized nuts, bolts and washersand provided with identification strips of PVC The terminals shall be made of copper alloy and shall be of box clamp type.

(e) Theboxes shall be aesthetic lookand weatherprooffor outdoor unit with MCB for branching lighting circuit.

DrawingsandData

AllDrawings,data,technicalparticulars,calculations,detailedliterature,catalogues,testcertificates etc shall be submitted alongwiththe bid/ after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

RenewableEnergy Capability

SolarPVRooftopsystemforstreetlightingonly

- The available shadow free roof top area shall be utilized to harness the solar energy. This shall provide a clean and renewable source of energy. The system shall comprise of PV Module(Thin film, poly crystalline), Power Conditioning Unit, and Solar Inverter with necessary accessories. The components shall be as per MNRE approved makes. The solar roof top system shall be grid connected based on Net Metering Regulation of KERC as amended up to date.
- The PV modules used shall of ≥ 250Wp ratings as per MNRE or KERC guidelines, the stricter one to be followed. The PV modules shall be poly-crystalline, thin film with efficiency assurance of 15%. The installation shall have proper space provision such that maintenanceshall be easy as the same shall ensure non reduction in PV panel efficiency.
- The street lighting shall be fed on independent radial buried cable circuits fed and controlled from a street lighting switchboard. The cables laid for outdoor lighting application shall be wire armoured.
- Each circuit shall be contactor switched, controlled by an astronomical timer and manual- auto control selectorswitch.Thecontactor,timeswitchandmanual control switchforeachareashall be incorporated in the LV road lighting distribution switchboard.
- Street lighting shall be Centralized, off grid solar power supply system suitable for powersupply to required number of streetlights to illuminate the complete treatment facility.Necessary interlocks shall be provided between main supply and solar supplyin such way that solar energy shall be used always and switchover to EB source automatically, when there shall be no solar energy available.

TheCentralizedsolarlightingsystemsshallcomprise:

(i) Solar modules.
(ii) Batteries(for12Hrbackup,SMFleadacidtype).
(iii) Inverter.
(iv) Cables.
(v) Required protection and control devices (Short circuit, reverse polarity, battery over charging, deep discharging etc) and wiring work.

Solar module shall convert solar energy into electrical energy and store into the battery. During the night-timestoredenergyshallbeconvertedtoACusingefficientinverterandshallbesupplied dtothe streetlights. The system shall be powered from the normal grid supply in case of cloudy days or in case of insufficient day light to charge the battery. Roof of “**AIR BLOWER BUILDING”** of STP area can be used for solar cell.

EarthingandLightingProtectionSystem

General

Theearthingandlightningprotectionsystemcoversearthingconductors,earthelectrodesand accessories.

- Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system.
- Cranerails,tracks,metalpipesandconduitsalsoshallbeearthedattwopoints.
- Steel RCC Columns, metallic stairs and rails of the building housing electrical equipment also shall be connected to nearby earthing grid conductor.
- Metallicsheaths/ screensandarmourofmulticorecablesshallbeearthedatbothends.
- Metallicsheathsandarmourofsinglecorecablesshallbeearthedattheswitchgeared only.
- Every alternate post of switchyard fence shall be connected to the earth grid by GS flat and gates by flexible lead to earthed post.
- Each Continuous laid length of cable trayshall be earthed at minimumtwo placesbyGS Flats to earthing system; the distance between the earthing points shall not exceed 20m.
- Lightning Protection System shall compromise vertical / horizontal air termination rod/strip, airterminationsupportsystem,downconductors,downconductorholders,test links,counters, and earth electrodes with chambers. Air terminations, down conductors and test links shall be of galvanized steel conductors and earth connection below the ground level shall be of mild steel. Lightning Protection System down conductors shall not be connected to other earthing conductors above the ground level.

ApplicableStandards

TheearthingandlightningprotectionsystemshallconformtotheNationalElectricalCode,National Building Code, CEA Regulations, and the latest applicable standards indicated below:

CodeofPracticefor Earthing : IS:3043-2018

ManualonEarthingofACPowerSystem : CBIP 302

CodeofPracticefortheProtectionof :
IS/IEC:62305-1to4

Buildingandalliedstructureagainst lightning

Hotdipgalvanizing :
IS:2629,2633,4759

Structuralsteel :
IS:2062&808

Welding :
IS:816

EarthingSystem

The electrical installation shall be required to be connected to the general mass of theearth by an earthing conductor. The material used for the earthing conductor shall be as follows:

(a) Conductorsabove groundlevelandintrenches: galvanisedsteelflat
(b) Conductorburiedinthe groundorembeddedinconcrete:mildsteel flat.
(c) PipeElectrode:Cast IronorGalvanized Iron
(d) RodElectrodes:MildSteel
(e) Lightningprotectionairterminationanddownconductorsforbuildings:galvanized steel

Allowance shall be made for reduction in the cross section of the steel over the design life of the earthing system.

Conductor sizes for burial in earth shall be calculated with indicated corrosion allowances as per IS 3043-2018. The minimum thickness shall be considered as 6mm.

The earth electrode system shall comprise one or more earth electrodes, earthing network, mesh or a combination of these in order to obtain the required earth electrode resistance.

Earthelectrodes whereused shall beofheavy-dutyGIpipeofnot less than40mm NB and 4150mm long. Where multiple electrodes are used, they shall be separated by a distanceof not less than the driven length.

Each earth electrode pipe shall be welded at the top to a mild steel plate to which the earthing tapes shall be connected. These connections shall each be housed in individual concrete inspection chamber set flush to the finished ground level and shall allow disconnection for testing of individual electrodes. The chamber shall be permanently marked ‘Electrical Earth’.

All materials used for the earth electrode installation shall be purpose made for the application and site conditions and shall be approved by the Employer’s Representative.

Unless otherwise stated all excavation for the installation of the earth electrodes and the inspection pit shall be carried out by the Contractor.

After the earth installation has been completed, the Contractor shall demonstrate to the Employer’s Representative that the resistance of the electrodes to earth and the continuity of the earth network are within the limits specified. Any additional earth electrodes and test instruments required for the tests shall be provided by the Contractor.

Marker posts and plates shall be provided to mark the route of buried tape or conductor electrodes. The markers shall be similar to those provided for cable routes.

Two earthing leads shall be used for voltage of the equipment above 250V and for rated voltage of 250V and below, one earth lead shall be provided.

Earth conductors laid in soil in the form of closed grid for the main plant area which covers transformer yard, substation building and all other individual buildings.

Transformer & DG neutrals. Lightning arrestors, capacitor banks, surge arrestors, 24 DC system, UPS, each downcomer of lightning protection system shall be directly connected to independent earth electrodes. Earth leads of DG & transformer shall be connected to TWO separate treated earth pits by TWO separate earth leads starting from neutral bushing. Any specific requirement of local authority regarding type of electrode shall be met with.

Main earthing conductors shall be buried in earth around each building at a minimum depth of 600mm at a distance of 1500mm from outer boundary of the building.

The earth grid of different areas shall be interconnected through test pits to the main plant area earth grid to enable measurement of ground resistance of each area separately.

Minimum two tap offs from main earthing loop outside the building shall be taken inside the building and connected to the earthing conductor embedded in floor slab with approximately 50mm cover or to the earthing conductor in cable trench.

Tap off from the main earth grid shall be taken with earth riser of 500mm length above ground level for outdoor and 200mm length for risers inside the building.

Separatefloorearthgridsshallbeformedandinterconnected formulti-storeybuildings.

LightningProtectionSystem

(i) The need of lightning protection has been established by calculating the overall riskfactor as per IS / IEC 62305 series.

(ii) Air termination system comprising of rods/mesh or combination of both shall beprovided and the methods used to determine the positioning of Air termination system shall be as per IS/IEC 62305.

(iii) Air termination system shall be connected to the earthing system by down conductors fixed along the outer surface of building Number & layout of the down conductors shall be as per IS / IEC 62305.

(iv) Each down comer shall be terminated to a separate treated test earth electrode which in turnshall be connected to station earthing system.

(v) The link shall be provided in the run of each down conductor at approximately 1000 mm above ground level.

(vi) Thelightningprotection airterminationnetworkshallbe fixedinsucha waythat theyremainin their installed position even during severe weather conditions. The necessary accessories suchas cleats, clamps, welding materials, bolts, nuts shall be provided.

(vii) Airterminationsystemshallbeconnectedtotheearthingsystembelowgroundbydown conductors.

(viii) Alljoints inthedownconductors shallbeofwelded /brazed type.

(ix) The lightningprotection system shall not be in direct contact with underground metallic service ducts, cables, cable conduits and metallic enclosures of electrical equipment.

MainEquipotentialBondingConductor

Mainequipotentialbonding conductors shallbe provided toconnectthe earth electrode system to conductive parts forming the works.

Equipotentialbondingconductorsshallhavethefollowing**minimumsizes**aspe rCl.No.
6.17.3 & 6.17.4. Actual equipotential bonding conductor size shall be calculated based on the fault conditions.

(a) <u>MainEquipotential Conductors</u>

- MainEarth Conductorburied in earth 65 x 10 mmMS flat
- MainEarth Conductoraboveground 65 x 10 mmGS flat
- Transformers,main switchboard 65x 10 mm GS flat andstandbygeneratorinstallation

- APFCPanel
  65 x10 mm GS flat
- interconnection to lightning protection system 50x10mmGS flat
- interconnectiontoMCCs
  50x10 mm/50x6 mmGS flat

(b) Equipotential Conductors

- interconnectiontoCPs
  25 x3 mm GS flat
- localpushbuttons
  14 SWG GSwire
- lightingdistributionboard
  4 SWG GS wire
- lightingandreceptacles
  ystem 12 SWG GS
  wire
- outdoorstreetlighting
  8 SWG GSwire
- ladder rack and cable tray at suitable points 25 x 3 mm GS flat
- handrailsandmetallicstru
  ctures 25 x 3 mm
  GS flat
- building reinforcement
  25 x3 mm GS flat
- incoming and outgoing process services 25x3mm GS flat
- steel structures comprising storage tanks, 25x3mm GS flat
  mezzanineplatform,cranerails,airh
  andling ductwork systems etc.

(c) LVMotors

- up to 10 kW
  8 SWG GS wire
- 10 to 20 kW
  4 SWG GS wire
- 20 to 50 kW
  25 x3 mm GS flat
- Above50 kW

50 x10 mm GS flat

- Earth electrode 40mmdia.4150 mmlongheavy Duty GI pipe electrode as per IS 3043- 2018

Notes:

1. Equipotential conductors shall interconnect between the device to be bonded and the main equipotential conductor.
2. Connections to building structural steelworkor concrete reinforcement shall bemade by a bolted connection to a tag welded to the steelwork or reinforcement bars. Unless otherwise specified at least two connections shall be made to the steelwork and reinforcement bars at the perimeter of each building at diagonally opposite locations.

CircuitProtectiveConductors

Anindependentcircuitprotectiveconductorshallbeprovidedforeachcircuitandmaycomprise one

or anyofthefollowingasappropriate:

- aseparate corewithinamulticore cable.
- a separate conductor installed within a conduit or trunking Steel conduit or trunking shall not be used as a circuit protective conductor.
- themetal sheath of an armoured cablethe sheath shall bebonded to themetalwork of the apparatus and to the apparatus earth bar if any.
- thecoppersheathofamineralinsulatedcoppersheathed cable.
- an independent earthing conductor MS or GS conductor run adjacent to the circuit it protects.

Circuit protective conductors associated with the main circuits supplying switchboardsand large electrical loads, i.e., motors in excess of 75 kW shall form a separate core of a multicore cable feeding the device or shall be an independent insulated copper conductor run adjacent to the supply cable. The size of the circuit protective conductor shall be calculated in such a manner as not to take into consideration the contribution of any other parallel or fortuitous earth paths.

Thearmouringofthesupplycableshallnotform thesolemeansofearthingaswitchboard or large electrical load.

Where the cable armouring or sheath shall be used as the circuit protective conductor it shall be securely bonded at both ends to the metalwork of the apparatus and to an earth bar. Particular care shall

be taken to ensure continuity across items of apparatus situated within a cable run and should the design of such items of apparatus not give adequate and lastingcontinuitythroughitsstructuralbodythenadditionalearthingclipsa ndconductors

shall be provided to independently bond the cable sheaths together. Similarly additional earthing clips shall be provided to bond the cable sheaths / armour to any piece of apparatus fitted with a special earth terminal should the earth connection for the termination gland be inadequate. Any additional earthing clips shall be fitted within the apparatus wherever possible.

InstrumentationEarth

An instrumentation earth bus, if required shall be provided in each control panel. This shall comprise a copper flat of cross section not less than 25 x 6 mm and length to suit the number of connections. It shall be mounted on at least two insulated supports and be provided with a single earth connection to the instrument plate type earth. If due to the physical size of a control panel more than one instrument earth bar shall be required, the additional bar shall be connected again with a single earth connection to the same point as before. In this fashion all instrument earths shall be connected radials from the same plate type earth point.

The earth pit for instrumentation system shall be separate. Electric earth pit shall not be used for earthing of instrumentation equipment. All signal cable screens (analogue and digital) shall be terminated onto the instrument earth bar. Signal cable screens shall be earthed at the control panel end only. Screens at the field end shall be tied back and insulated. Connection between instrument earth bar and instrument plate type earth pit shall be insulated copper wire such that earth pit resistance shall be less than 1 Ohm at panel.

SPD s associated with the control and instrumentation system shall be earthed to the instrument earth in accordance with the SPD manufacturer’s recommendations.

Galvanising

Wherever galvanising has been specified, the hot dip process shall be used. Thegalvanised coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated below:

a) FabricatedSteel

Thicknesslessthan 2mm, Butnotless than12 mm	340gms/ sqm
Thicknesslessthan5mm,butnotlessthan2mm	460gms/

Thickness 5 mm and over	sqm 610gms/sq m

b) Fasteners

Up to nominal sizeM10	270gms/ sqm
OverM10	300gms/sq m

Burrsshallberemovedbeforegalvanising.Anysitemodificationofgalvanised parts should be covered well by zinc rich primer and aluminium paint.

Insulating Mat

Insulatingmatsshallconformto IS15652/IEC61111.TheSuppliershallbemadefromthematerial Elastomer and free from any insertions leading to deterioration of insulating properties for floor covering in front or the MV and LV switchgear along its length.

Mats shall be free from fabric insertions and fibrous material and resistant to acid, oil & low temperature. Mats shall be solid and no perforated. The upper surface shall have small aberration (roughsurfacewithoutedge)toavoidslippereffectswhilethelowersurfaceshallbeplaneor couldbe finished slip resistant without affecting adversely the dielectric property of the mat.

Thematsshallhaveclass-Dwithminimumthicknessof3.5mmwithoutnegative tolerance.

Matsofbothtypesshall haveaminimumwidthof900mm.Matsshall besatisfactorilyvulcanized, free from blisters, pinholes, cracks, embedded foreign matter and other physical defects.

Minimum insulation resistance for the mats with tap water (i.e., wet condition) will be of 1,00,000MΩ,whenmeasuredwith5000VMeggeror10,00,000MΩ,whenmeasuredwith500V Megger.

InsulatingmatsshallbemarkedwithstandardmarksandBureauofIndianStandards number.

PreferredMakes/ Manufacturers

ListofpreferredmakesforElectricalEquipment/Items

SL. NO.	DESCRIPTION	VENDOR/ MANUFACTURER / MAKE

1	Distribution Transformers	M/ sCromptonGreavesLimited M/S Volt Amp M/SBharat Bijlee M/sKirloskar ElectricCo.Ltd.

2	11kVMetalenclosed switchboards	M/ sSiemens M/s ABB M/s BHEL M/sSchneider Electric
3	DigitalProtectiveRelays / meters	M/s ABB M/ sSchneiderElectric M/s L&T M/s GE M/s Siemens M/s Mitsubishi Electric
4	CurrentTransformers-LT	M/s AE M/s ECS M/sPrag ati M/s Kappa
5	VoltageTransformers- LT	M/s AE M/s ECS M/sPrag ati M/s Kappa
6	LVSwitchgears&Controlgea rs (PCC’s / MCC’s / PDB’s)	M/ sSchneiderElectric M/s ABB M/ sSiemens M/s GE M/sL&T M/s Mitsubishi Electric Note:Authorizedlicensepart ners/ System Integrators of above manufacturer’s shall

		be TTP certified for IEC 61439

7	LTPowerCapacitors/Panel	M/s ABB M/ sCGPowerSystems M/s Universal M/ sMadhav M/s BHEL M/sL&T M/s Mitsubishi Electric Note:Authorizedlicensepartners/ System Integrators of above manufacturer's shall be TTP certified for IEC 61439
8	DieselEngines	M/s Cummins M/s Caterpillar M/ sKirloskarOilEngines M/s Perkins M/s Crompton Greaves
9	AlternatorsforDGSets	M/ sKirloskarElectric M/s CGL M/sBHEL M/s JyotiM/sSt amford M/sLeroy-Somer
10	VariableFrequencyDrives/ Soft Starters	M/ sSiemens M/s ABB M/s GE

		M/s Schneider Electric M/sMitsubishiElec tric M/s Yaskawa Note:Authorizedlicensepartners/ System Integrators of above manufacturer’s shall be TTP certified for IEC 61439

11	Batteries	M/ sExideIndustries M/s AMCO M/sHBL-NIFE M/sAmararaja
12	BatteryChargers	M/ sUniversalInstruments M/s Amara raja M/sChabbi Electricals M/sHBL-NIFE
13	LightingFixturesand Accessories	M/ sPhilips M/s ABB M/ sCromptonGreavesLimited M/s Wipro M/sBajajElectricals M/sLegrand
14	LTBusDucts	M/s Star Drive M/sPowerGea r M/sC &S ElectricLimited
15	PowerCablesandWires	M/ sUniversalCables M/s Polycab M/ sHavells M/s Finolex M/s NICCO M/s Delton M/sC &S ElectricLimited
16	MLDB’s,LDB’s,SDB’s,MCB’s, RCCB’s	M/s

		Havells M/sStand ard M/s Legrand M/s L & T M/s Siemens M/sSchneider Electric

17	Switches,Plugs,Sockets, Pushbuttons	M/ sLegrand M/s Havells M/s Anchor M/s Cona M/sC &S ElectricLimited
18	CeilingFans	M/s Havells M/sCrompt on M/s Orient M/s Bajaj M/s Usha
19	CableterminationKits	M/s Raychem M/sMahindr a M/s REPL M/s 3M

Note:

All products shall be completely manufactured in the country of Origin as indicated. Assembled products shall not be accepted.

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

Note-2: In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:

(i) Copies of Type Test Certificate (testing done as per latest standards) not older than 5 years for the items offered.

(ii) Demonstrate that the proposed makes are “equivalent” to the approved makes. The contractor shall ensure that alternate makes proposed, shall comply completely to the tender specifications, before the same is submitted

for approval.

(iii) SubmitISOcertificatesfortheOEM.

(iv) Submitqualitycertificatesthattheequipmentadheresto,asrequiredunderthiscontract.

(v) Submit product brochures for the proposed equipment, with information on spares availability and service setup in employer's country.

(vi) Manufacturer involved in manufacture of specified proposed equipment for at least 10 years before bid date.

(vii) End user performance certificates for minimum 10 successful individual installations of similar size as per this contract with the proposed equipment and model no, commissioned in last 5 years before bid date and satisfactorily operating for at least five years before bid date. Contractor to submit end user reference certificates for each of the installations referenced.

(viii) Manufacturertoprovidefullcontactinformationforeachreferenceaspartofsubmissi on.

EndofPart-6

PART6

GENERALELECTRICALREQUIREMENTS

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PART6

GENERALELECTRICALREQUIREMENTS

Introduction

The general requirements include design, manufacture, inspection and testing at works, supply and deliveryatsite,unloadingandstoringtheequipmentatsiteofinstallation,testingandcommissioning of the equipment at site listed below. All the electrical and instrumentation equipment to be supplied under this contract have to be of reputed makes. The equipment of those manufacturers, who have sufficient proven experience of manufacturing the respective equipment of similar capacity, shall be considered. The respective equipment should have been manufactured, supplied, installed, commissioned successfully and should be running satisfactorily since at least last 5 years continuously. Certificatesfromthe end users, regardingtheirsatisfactoryPerformances, shallhave to be submitted in this regard. All equipment shall be OEM (Original Equipment manufacturer) type only.

Particularrequirementsofallelectricalequipmentarecoveredunder‘Part12:ParticularRequirements – Electrical’ of this Specification. All the equipment / items shall conform to latest applicable standards specified. In case of Conflict between standards and this specification, this specificationshall govern.

Equipment

(n) Transformers
(o) MVMetalenclosedswitchboards&switchgears
(p) 415VMetalenclosedswitchgearsPCC/MCC/DGPCCPanel
(q) Powercapacitorandcontrolpanel(APFC)
(r) SoftStarters
(s) DieselStandbyGeneratorwithAMFControlPanelandSynchronizingpanel
(t) Battery,BatteryChargerandDCDistributionBoard
(u) VariableFrequencyDrives
(v) Non-SegregatedBus Duct
(w) Power&Controlcables
(x) CableCarriersystem
(y) Lightingsystem
(z) EarthingandLightningprotectionsystems

Transformers

Transformersystemshallhaveprovisionofinter-operabilitywithinstrumentationcontrolssystem.

6.3.2 Applicable Standards

The design, manufacture, testing and performance of equipment shall comply with all currently applicable standards, codes of practice, regulations and safety codes in the locality where the equipment will be supplied. Nothing in this specification shall be construed to relieve the VENDOR/BIDDER of his responsibility. In case of conflict between these standards and this specification, more stringent of the two requirements shall govern.

The codes and standards mentioned in the various specifications and requirements specified in the bid document shall be latest as on the day of award of contract of theworks unless otherwise specified. Contractor shall be responsible to inform to the Consultant/ Employer in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Employer may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirementsoftheprojectordoesnotimpactsafetypractices.Anycostimpa ctarisingout of such revisions shall be mutually agreed

Someofthecurrentlyapplicablestandardsareindicated below

PowerTransformer	IS:2026/IEC:60076
FittingsandAccessories	IS:3639
OutdoortypeOilimmerseddistributiontransformersupt o 2500kVA, 33kV Transformer Procedurefor testing	IS:1180LatestAmend.4 IS:1180/IS:2026
LoadingGuideofoilimmersedtransformer LoadingGuideforDry-typePowerTransformers	IS:2026-7,IEC:60076-7 IS:2026-12,IEC:60076-12
TransformerOil	IS:335/BS 148/IEC:60296
Bushings	IS/IEC:60137,IEC60137
Degreeof Protection	IS/IEC60529,IEC60529
DoublefloattypeBuchholz Relay	IS:3637
Electricalinsulationclassifiedbythermalstability	IS 1271/BS:2757/IEC:60085
CodeofPracticeforselection,installation,andMaintena nceof transformers	IS:10028
ManualonTransformers	CBIPPublicationNo.317

FeaturesofConstruction

Thetransformertankshallbemadefromhigh-gradesheetsteel,suitablyreinforcedbystiffenersmade of structural steel sections.All seams, flanges, lifting lugs, braces, and other parts attached to the tank shall be welded. The interior of the tank shall be cleaned by sand blasting and painted with two coats of heat resistant, oil insoluble paint. Adequately sized manholes shall be provided for ease of inspectionandmaintenance.Steelboltsandnutsexposedtoatmosphere,shallbegalvanized.Thetank cover shall be removable and shall be suitably sloped so that it does not retain rainwater.

Liftinglugsandeyeboltsshallbesolocatedthatasafeclearanceshallbeobtainedwithoutthe useofa spreader, between the sling and transformer bushings.

Transformersshallbeprovidedwithfixedtyperadiators.Finsoftheradiatorsshallnothavesharp edges and shall be rounded in shape.

The transformer core shall be constructed from high grade, non-ageing, cold-rolled, grain oriented, siliconsteellaminations.Thesteellaminationsshallbeof"core"type.Eachlaminationshallbecoated with insulation which shall be unaffected by the temperature attained by the transformer during service. Core laminations shall be annealed, and burrs removed after cutting. Cut edges shall be insulated. The framework and clampingarrangements of core and coil shall be securelyearthed inside the tank by a copper strap connection to the tank.

WindingsshallbeofelectrolyticCopperof99.99%purity.

Windings and insulation shall be so arranged that free circulation of oil shall be possible betweencoils, between windings, and between winding and core. The windings shall be fully shrunk under vacuumbeforeassembly.Highvoltageend-windingsshallbesuitablybracedtowithstandshortcircuit stresses and stresses caused up by surges.

ThesequenceandorientationofHV /LVsidephaseandneutralbushingsshallbeasspecifiedinthe latest edition of relevant IS.

TransformershalloperatewithoutinjuriousheatingattheratedkVAandatanyvoltageupto+10% of the rated voltage of any tap. Transformer shall be designed for 110% continuous over-fluxing withstanding capability.

TransformershallbeprovidedwithZerosequence/ earthfaultcurrentprotectiononLVside transformer feeder protection. (Neutral CT to be provided in case of solid grounding)

WindingConnections

WindingsshallbeofHV:Delta&LV:Star,vectorgroup Dyn11.

Rating

TheratingoftransformersshallbeasperstandardratingsshowninIS1180/ CBIPPublication317. The energy efficiency level (EEL) of the transformer shall comply with the latest amendment of IS 1180 with minimum EEL of Level II.

Typeofcooling

Thetransformersshallbeoilimmersedwithnaturaloilcirculation,typeONAN.

Impedanceand losses

Thepercentageimpedance,noload&loadlossesshallbeasperIS1180latestamendment.

Oil

Transformersshallbesuppliedcompletewithtransformeroil,itshallbe‘’PCBfreeandp olycyclic Aromatic Hydrocarbons free mineral oil’’ OR Synthetic ester Oil

Performancerequirements

(h) The transformers shall be suitable for operation without danger on to any particular tapping at the rated kVA provided that the voltage does not vary by more than ± 10% of the voltage corresponding to the tapping.

(i) The transformers shall be suitable for continuous operation with a frequency variation of ±5% of rated frequency, combined voltage and frequency variation should not exceed 10%.

(j) All transformers shall be capable of withstanding external short circuit without damage as perIS 2026.

(k) The transformers shall be capable of continuous operation in accordance with relevant IS for loading of oil immersed transformers.

(l) The neutral terminal of star windings shall be designed for the highest over current that can flow through this terminal.

(m) The temperature rise of oil & windings over the specified ambient temperature shall not exceed the limits given below with air as cooling medium when tested in accordance with IS 2026(Part-2).

Topoil(measuredbythermometer)	:	35°C
Winding(measuredbyresistance)	:	40°C

(n) Noise level of transformers measured at a distance of 1 metre shall be as per limits specified in NEMA standard/IS 2026-10.

Tap Changer

For transformer of rating less than or equal to 500kVA, tap changing shall be carried out by means of an off circuit externally operated self-positioning switch when the transformer is in de-energized condition. Tapings shall be provided on the higher voltage winding for variation of HV voltage from plus 5% to minus 10% in steps of 2.5%. For transformer of rating greater than 500kVA on load tap changershallbeprovidedonHVsideforvariationHVvoltagefromplus5%tominus15%instepsof 2.5% with Remote Tap Changing Controller (RTCC), Automatic Voltage Regulator (AVR) etc.

OnLoadTap ChangingGearforTransformer (above 500kVA)

(g) The OLTC gear shall be designed to complete successfully tap changes for the maximumcurrent to which transformer can be loaded i.e., 150% of the rated current. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault currents without injury.

(h) Whenatapchangehasbeencommencedit shall becompletedindependentlyoftheoperationof the control relays and switches. Necessary safeguard shall be provided to allow for failure of auxiliarypower supplyor anyother contingencywhich mayresult inthe tap changer movement not being completed once it shall be commenced.

(i) Oil in compartments which contain the making and breaking contacts of the OLTC shall notmix with oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator. A Buchholz relay shall be installed inthe above pipe. The segregated compartment (conservator) shall be provided with a prismaticoil level gauge.

(j) Oil, in compartments of OLTC which do not contain the make and break contacts, shall be maintained under conservator head by valve pipe connections. Any gas leaving these compartments shall pass through the Buchholz relay before entering the conservator.

(k) Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasketed and bolted cover with liftinghandle.

(l) OLTC driving mechanism and its associated control equipment (Local) shall be mounted in an outdoor, weather-proof cabinet with IP65 protection which shall include:

(xvii) Drivingmotor(415V,3-phase,50Hz.ACsquirrelcage).
(xviii) MotorstartingcontactorwiththermaloverloadrelaysisolatingswitchandMCB.
(xix) Duplicate sources of power supply with automatic changeover from the running source to the standby source and vice versa.
(xx) Controlswitch:Raise/Off/Lower(springreturntonormaltype).
(xxi) Remote/Off/Localselectorswitch(maintainedcontact type).
(xxii) Mechanical tap position indicator showing rated tap voltage against each position andresettable maximum and minimum indicators.
(xxiii) Limitswitchestopreventmotorover-travelineitherdirectionorfinalmechanical stops.
(xxiv) Brakeorclutchestopermitonlyonetapchangeatatimeon manualoperation.
(xxv) Emergencymanualoperatingdevice(handcrankorhand wheel).
(xxvi) Afive-digitoperationcounter.
(xxvii) Electricallyinterlockedreversingcontactors(preferablyalsomechanicallyinterlocked).
(xxviii) 240V,50Hz.ACspaceheaterwiththermostatandMCB.
(xxix) InteriorlightingfixturewithlampdoorswitchandMCB.
(xxx) Gasketedandhingeddoorwithlockingarrangement.
(xxxi) Terminalblocks,internalwiring,earthingterminalsandcableglandsforpowerand control cables.
(xxxii) Necessarydigitalprotectionrelays,contactors,currenttransformersetc.

(i) ControlRequirementsforOLTC
Thefollowingelectricalcontrolfeaturesshallbeprovided:

(v) Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.
(vi) Onlyonetapschangefromeachtapchangeimpulseevenifthecontrol switchesorpush button shall be maintained in the operated position.
(vii) Cut-off of electrical control when manual control shall be resorted to. Cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.
(viii) Cut-offofelectricalcontrolwhenittendstooperatethetapbeyonditsextreme position.

(i) AutomaticControlof OLTC
AutomaticOLTCcontrolshallincludethefollowingitems:

(vi) Voltagesettingdevice
(vii) Voltagesensingandvoltageregulatingdevices.
(viii) LinedropcompensatorwithadjustableRandXelements.
(ix) Timer 5-25 seconds for delaying the operation of the tap changer in the first step forevery tap change operation.
(x) Adjustabledeadbandforvoltagevariation

(j) OLTCPanel:

TheOLTCremote controlequipment shall be suitablefor 110V DC supplyand shallbe housed inanindoorsheetsteelcubicletobelocatedinaremote-controlroom.TheOLTCcontrolpanel shall comprise of rigid welded structural frames made of structural steel section or of pressed and formed cold rolled steel and frame enclosures, doors and partitions shall be of cold rolled steel of thickness 2mm. Stiffeners shall be provided wherever necessary. All doors, removable covers and plate shall be gasketed all around with neoprene gaskets. Panel shall be dust, weather and vermin proof providing degree of protection of IP54, colour of finish shade for interior and exterior shall be glassy white and light grey semi glossy shade 631 of IS-5 respectively. Earthing bus shall be of 25 x 6 mm copper.

TheOLTCremotecontrolequipmentshallcompriseofthefollowing:

(xiv) Controlswitch:Raise/Off/ Lower (Springreturntonormaltype)
(xv) Auto/Off/Manualselectorswitch(Maintainedcontact type)
(xvi) Tappositionindicator.
(xvii)Fasciatypealarmannunciationswith“accept”and“lamptest” facilities.

- A.C.supplyfailure.
- Drivemotorautotripped.
- Tapchangedela

yed. (xviii)Necessary
auxiliary relays.
(xix) Lampindicationsfor:

- Tapchangeinprogress.
- Lowerlimitreached.
- Upperlimit reached.

(xx) DoublecompressionCableglandsforpowerandcontrolcables.
(xxi) 240Vratedpanelspaceheaterwiththermostatand ON-OFFMCB.
(xxii) LED type Energy efficient (lumen per Watt shall be specified) interior lighting fixture with lamp and door switch.
(xxiii) MCB/ HRC fuses.
(xxiv) Terminalblocks.
(xxv) Internal wiring.
(xxvi) Earthingterminal.

OffLoadTapChangingMechanismforTransformer(Less thanorequalto 500kVA)

Offcircuittapchangingmechanismshallcomprisethefollowing:

- Operatinghandleofwheel,accessiblefromground level.
- Tappositionindicator.
- Padlockingarrangement.
- The tap-changer connections and contacts shall be accessible through an access hole havinga bolted gasketed cover.

MarshallingBox

Marshallingboxshallbeprovidedtomarshaltemperatureindicatorswithauxiliarycontacts,Buchholz relay and bushing CT shall marshal to the contacts/terminals of electrical devices mounted on the transformer

- Theinterconnectioncablingbetweenthemarshallingboxandtheaccessorydevicesbyeither PVC insulated FR wires in GI conduits or PVC insulated inner extruded PVC, Outer sheath PVC FR armoured cable and

- Necessary compression type, brass cable glands (at easily accessible location) at the marshalling box for the above-mentioned cables.

The marshalling box shall be tank mounted, outdoor type, IP55 protected, weather-proof, sheet-steel(2 mm thick) enclosed, with hinged door having padlocking facility. Colour finish shall be epoxy paint,powdercoatedwithminimumthicknessof 50micronsanddarkgreyshadeRAL632.All doors, covers and plates shall be fitted with neoprene gaskets. Bottom shall be at least 600 mm from floor level and provided with gland plate and cable glands as required. Top surface shall be sloped.

All contacts for alarm, tripand indicationcircuits shall each be potential free, wired for auxiliaryD.C. supplyasspecifiedandbroughtouttoseparateterminalsattheterminalblocksinthemarshalling-box. Terminals shall be rated for 10A.

Wiringshall be FRLS/HFFR with multistranded, copper conductors of sizes not smaller than 1.5 sq.mmforcontroland2.5sq.mmforCTcircuits.CTterminalsshallbeprovidedwith shorting& earthing facility.

ThemarshallingboxshallbeprovidedwithglasswindowsoastomaketheWTIandtheOTIdials visible from the outside without opening the door.

The marshalling box shall house the winding temperature indicator (WTI, 150 mm dial 240-degree scale), the oil temperature indicator (OTI, 150 mm dial 240-degree scale), terminal block, 60W anti- condensationheater, 5/15Aindustrial typefive pin socket and a LEDfixture, suitablefor operatingon 230VAC.ContactsofBuchholzrelay,WTI,OTI,

magneticlevelgauge,PRD,OSRshallbewiredup to the terminal block.

FittingsandAccessories

Thefollowingfittingsandaccessoriesshallbeprovidedwithtransformer:

(w) Nameplate,ratingplateanddiagramplateasperIS 1180.

(x) Twoearthingterminalsonoppositeendsofthetransformertank.

(y) Neutral earthing bar of copper of specified section installed from the neutral bushing to ground level suitably supported along its run-on porcelain insulators, together with clamping arrangements at neutral bushing and for two Employer's earth conductors. The supporting insulators shall be tank mounted.

(z) Inspectionmanhole(s)withcover(s)onthetopcoverofthe transformer.

(aa)Lifting lugs or eyes for lifting of fully assembled transformer, core assembly and tank core by crane.

(bb)Conservator, complete with filling plug, sump and drain valve, and a shut-off valve on the pipe connection between transformer tank and conservator, to permit removal of the conservator.The conservator shall be designed to maintain an oil seal through a temperature range of 100 Deg C.

(cc) Oil level gauge indicating oil level at minimum, 300C and maximum

operating temperature. (dd)Weather-

proofdehydratingbreatherwithclearpolycarbonatedesiccantcontainerweightofthe desiccantshall meet 400chargelifedays.Desiccanttype shall beself-indicatingbreadsilica gel
asthedehydratingagent.

(ee)For all transformers, magnetic type oil level gauge with low oil level alarmcontact, mounted on the conservators with waterproof and dustproof terminal box and shall be wired to marshalling box.

(ff)Gas detector relays with separate alarm and trip contacts complete with shut-off valves shall be wired to marshalling box.

(gg)Separate drain valve, oil sampling valve with plug and top filter valve shall be provided on the tank and shall be leak proof after commissioning.

(hh)Explosionventwith diaphragm forrelieving pressure inside the transformer.Thedeviceshall be rain proof after operation. For transformers of 500kVA and above an equalizer pipe connecting the pressure relief device to the conservator shall be supplied.

(ii) Buchholz relay, pressure relief device and winding and oil temperature protection with alarm and trip contacts shall be provided on all

transformers of ratings 1000 kVA and above.

(jj)Separately mounted, waterproof, and dustproof marshalling box housing the Buchholz relay wiring, oil level low wiring, oil temperature indicator and winding temperature indicator with alarm and trip contacts and marshalling facilities for electrical devices mounted on transformer including load management signal shall be provided to give an information about the over loading condition of the transformer and all signals shall be wire able to alarm annunciation. (The signal shall not give indication for momentary over loading). The marshalling box shall be in accordance with IS 13947-1. The degree of protection shall be IP65 with space heaters etc.

(kk)For transformers rated 500KVA and above. Adequate number of air vents for relieving trapped air during oil filling / during maintenance and shall be leak proof after commissioning.

(ll)

Thermometerpocketsandsensingelementmountedonthetransformertankcover for measuring top oil temperature.

(mm)Four jacking pads for lifting the transformer

with jacks.

(nn)Pullingeyesandskidsforthemovementofthetransf

ormer. (oo)Bidirectional wheels for movement of

the transformer.

(pp)Aladderassemblyshallbeprovidedtoreachthetopofthetransformerformaintenance work. It shall be possible to padlockthe ladder to thetransformer tankso that ladder cannot be removed. Usage of transformer structure / marshalling boxes etc. as means to climb transformer are not acceptable.

(qq)Accessoriesforclampingthe wheelmountedtransformer tothefoundationinordertowithstand earthquake forces with a seismic acceleration of 0.2g.

(rr)

Transformershallbesuppliedcompletewithinsulatingoilrequiredforfirstfilling plus10% excess oil in non-returnable drums (With gas analysis report).

CableTerminations/Cabling Requirement

Cable termination boxes for transformers shall be suitable for dry termination of HV and LV cables. Non-magneticglandplatesshallbeprovidedfortheterminationof cables.Maximumsizeofthecable and number of cables that can be terminated shall be indicated.

Itshallbepossibletoremovethecableboxeswithoutdismantlingthecableglandingor drainingthe oil. Disconnecting links shall be provided to facilitate testing of the cable.

Alltransformersshallbeprovidedwithalarmannunciationonbreakercontrolpanel.

ToleranceonLosses

Thepermissibletolerancesontheguaranteedvaluesoftransformerlossesshallbeasper IS2026.The values of load- losses and No-load losses shall be within the values given in latest edition of CBIP.

Lossesat50%load&100%loadshallbeminimumEnergyEfficiencyLevel(EEL) - 2asperlatest amendment of IS 1180.

Costloadingshallbedoneforcapitalizationoflossesattimeofbidevaluationforalltrans formersas per CBIP Manual on transformers.

Rejection

The Employer or Employer’s Representative reserves the right to reject the transformer if the same does not meet the specification requirement, subject to tolerances as per IS 2026. The impedance valuesdifferenceandtemperaturerisevaluesshall notexceedfromtheguaranteedspecifiedvalues. Therejectedtransformersshallbereplacedbytransformerscomplyingwiththerequir ementsofthis specification at the Contractor’s cost.

If the commissioning of the project shall be likely to be delayed by the rejection of a transformer, the Employer’s Representative reserves the right to accept the rejected transformer until the replacement transformershallbemadeavailable.Transportingtherejectedandreplacementtransform ersaswellas installation and commissioning of both the transformers shall be at the Contractor's cost.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedlitera ture,catalogues, type test certificates of typical transformer etc shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

QualityAssurancePlan (QAP)

QAP shall list and define in sequential order all process control activities, inspection and tests proposedtobeperformedontheequipment/materialstartingfromcomponentprocur ementandfrom testing stages to product dispatch. The QAP shall indicate and identify the applicable standards, detailed description with diagramthe procedure, acceptance criteria,extentof checkand recordto be generated.

MVMetalEnclosedSwitchboards&Switchgears

MVMetalenclosedSwitchboardsandSwitchgearsystemshallhaveprovisionsuchthat inter- operability with instrumentation control system.

Applicable Standards

Theswitchgearanditscomponentsshallconformtothelatestapplicablestandardsspecifiedbelow:

The design, manufacture, testing and performance of equipment shall comply with all currently applicable standards, codes of practice, regulations and safety codes in the locality where the equipment will be supplied. Nothing in this specification shall be construed to relieve the VENDOR/BIDDER of his responsibility. In case of conflict between these standards and this specification, more stringent of the two requirements shall govern.

The codes and standards mentioned in the various specifications and requirements specified in the bid document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant/Employerin caseofanyrevisions/re-affirm/amendmentinthe relevantcodes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Employer may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed

Someofthecurrentlyapplicablestandardsareindicated below

SwitchgearGeneralRequirements ACCircuitBreakers	IS/ IEC:60947,BSEN:60947, IS/IEC:61439-1 IS/IEC62271-100
FactoryBuiltAssembliesofSwitchgearandControl GearForVoltagesUptoandincluding1000VACand 1500 V DC	IS:8623,BSEN:61439-1,IS/IEC 61439-1 IEC62271-200
CurrentTransformers	IS:16227/BS:7626/ IEC61869-2
VoltageTransformers	IS:16227/BS:7625/IEC:60869-3
ArrangementforSwitchgearBusbars,MainConnections and Auxiliary wiring	IS:5578,11353,BS:159
BusbarSupportinsulators	IS:2544/BS:3297/IEC:60273
Degreeof Protection	IS/IEC:60529,IEC:60529
ElectricalRelaysforPowersystemprotection	IS/IEC:60255

ElectricalIndicatingInstruments	IS:1248/BS: 89/IEC: 60051
HighVoltage Fuses	IS:9385/BS:2692/IEC:60282

ACElectricityMeters	IS:722, 8530/BS:5685/IEC: 60145, 60211
Specificationforcopperrodsandbarsforelectrical purposes	IS:613
Codeofpracticeforphosphatecoatedironandsteel	IS:6005/BS: 3189
AlternatingcurrentSwitchesforvoltagesabove 1000V	IS:9920/ IEC:60129, 60265
HRCCartridge fuses MiniatureCircuitBreakers	IS:13703-2/ BS1362/IEC 60269 IS/IEC:60898
Toggleswitches	IS:3452/BS: 3676
Codeofpracticeforselection,installationand maintenance of switchgear and control gear	IS: 10118
AirBreakswitches	IS/IEC60947-3,BSEN60947-3/ IEC:60947-3
ClassificationofHazardousareashavingFlammable gases and vapors for Electrical Installation	IS5572,IEC60079-10
Electricalapparatusforexplosivegasatmospheres- General Requirements Faultlevelcalculation Testing Guide	IEC60079 IS: 13234 / IS:2026 ANSI/IEEEC.37.2 0.7

ConstructionalFeatures

Switchgeardesignshallbeofmetalenclosed,singlefront,freestanding,floormountedandfully compartmental execution having separate sections for each circuit

(a) control,meteringandrelayingdevices

(b) circuitbreaker/disconnectingswitch

(c) busbars

(d) voltagetransformersand

(e) powercableterminations&currenttransformers

Each Circuit shall have a separate vertical panel with distinct compartments for main bus bars, circuit breaker,cableterminationandauxiliarydevices.Theadjacentpanelsshallbecompletelyseparatedby steel sheets except in bus bar sheet compartments where insulated barriers shall be provided to segregate adjacent panels. Compartments with doors for access to operating mechanism shall be so arrangedasnottoexposehighvoltagecircuits.Switchgearcubicleshallbeprovidedwithhingeddoor on the front with facility for locking door handle. Stiffeners shall be provided wherever necessary to strengthen the door and side covers. Switchboard shall be dust and vermin-proof and shall have a degree of protection of enclosure of IP 4X and the relay and meter compartments shall have a degree of Protection not less than IP 52. All removable covers shall be gasketed all around with neoprene or superior gaskets.

Instruments, relays and control devices shall be flush mounted on hinged door of the metering compartment located in the front portion of cubicle. The metering compartment shall be properly shielded to prevent maloperation of electronic equipment such as numerical / static relays due to electro-magneticfields.Alltransformersshallbeprovidedwithalarmannunciationonbreaker control panel.

Separateremovableglandplatesshallbeprovidedforpowerandcontrolcables.Theglandplatefor the power cables shall be of non-magnetic material for single core cables

Each switchgear cubicle shall be fitted with a label on the front and rear of the cubicle. Each switchboardshallalsobefittedwithlabelindicatingtheswitchboarddesignation,ratingandduty. Each relay, instrument, switch, fuse and other devices shall be provided with separate label.

Thefullydraw-outmodulesshallhaveallthecircuitcomponentsmountedonwithdrawabletypesteel chassis. All power and control connections shall be of the draw out type. It shall be possible to withdraw the chassis mounted circuit components without disconnecting any connections. All draw out contacts shall be of silver-plated copper.

In case of circuit breaker compartments, suitable barriers shall be provided between breaker and all control, protective and indication circuit equipment including instrument transformers such that no live partsare accessible. Externalcable connectionsshallbethrough separate cable compartmentsfor powerandcontrolcables.Safetyshuttersshallbeprovidedtocoverupthefixedhighvoltagecontacts on busbars when the circuit breaker carriage shall be moved to ‘test’ and ‘isolated’ positions.

Onemetalsheetshallbeprovidedbetweentwoadjacentverticalsectionsrunningtothefullheightof the switchboard except for the horizontal busbar compartment. However, eachshippingsectionshall have metal sheets at both ends. After isolation of the power and control connections of a circuit, it shall be possible to

carry out maintenance in a compartment safely, with the busbars and adjacent circuits alive.

All sheet steel work shall be phosphate coated in accordance with the following procedure and in accordancewithIS:6005“CodeofPracticeforPhosphatecoatedIronandSteel”.Oil,grease,dirtand swarfshallbethoroughlyremovedbyemulsioncleaning.Rust andscaleshall beremovedbypickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

Afterphosphatecoated,thoroughrinsingshallbecleanwaterfollowedbyfinalrinsingwithdilute dichromate solution and even drying.

The phosphate coating shall be followed by the application of two coats of readymixed stoving type zincchromateprimer.Thefirstcoatmaybe“flashdried”whilethesecondcoatshallbestoved.After application of the two coats of primer finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests.

Thefinal finishedthicknessofpaintfilmonsteelshallnot belessthan80micronsandshall not be more than 120 microns. Finished painted surface of panels shall present an aesthetically pleasing appearance free from dents and uneven surface.

Asmallquantityoffinishingpaintshallbesuppliedforminortouchinguprequiredatsiteafterthe installation of the panels.

Circuit Breaker

Circuit breakers shall be vacuum type (VCB) with three separate single pole interrupting units, operated through a common shaft bya sturdyoperating mechanism. Surge Arrestors shall be provided foreachmotor/transformerfeeder.CircuitBreakersshallbere-strikefree,storedenergyoperatedand trip free type. Circuit breaker along with its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow easy movement. Plugs and sockets for power circuits shall be silver faced and shall be insulated withsuitable insulating material shrouds. All correspondingcomponents of circuit breaker cubicles of same ratingshall be interchangeable with one another. Anti-pumping relay and trip coil suspension relay shall be provided.

All VCB trucks of same rating shall be interchangeable. Closing coil shall be operable with control supplyvoltagevariationintherangeof 85-110%andtrippingcoil shall beoperableintherangeof 70- 110%.

There shall be ‘Service’, ‘Test’ ‘Fully withdrawn’ positions for the breakers. In the ‘Test’ position the circuitbreakershallbecapableofbeingtestedforoperationwithoutenergizingthepowercircuits,i.e., the control circuits shall remain undisturbed while the power contacts shall remain disconnected.
Separate limit switches, each having a minimum of 2 ‘NO’ + 2 ‘NC’ contacts, shall be provided for both ‘Service’ and ‘Test’ positions of the circuit breakers. All these services, test, fully withdrawn, springchargeandalsobreakerON/OFFshallbevisible mechanicallyfromoutsidethebreakerpanel when the front door is closed.

Electrical closing & tripping shall be performed by shunt trip & close coils both in Local, Off & Remote mode, selector switch lockable in “Local” position shall be provided on the cubicle door.

‘Red’and‘Green’indicatinglampsshallbeprovidedoncubicledoortoindicatebreaker closeand open positions. Breaker “Service”, “Test” and “breaker readiness” positions shall be indicated by separate indicating lamps on the cubicle door.

Connectionofthecontrol/ interlockingcircuitsbetweenthefixedportionofthecubicleandthe breaker carriage shall be preferably by means of plug socket arrangement.

10%sparefeederswithatleastoneforeachtypeofhighest ratingshall beprovidedineach switchgear.

Surgearrestorsshallbeprovidedforallincomerandtransformerfeeders,whichshallb emetaloxide gapped or gapless, type generally in accordance with IEC 60099-1 and suitable for indoor only.

Main Busbar

Busbars shall be fully insulated with flame retardant heat shrinkable sleeves with removable shrouds for protecting all joints. The busbar phases shall be clearly identified with suitable colour coding at bothendofeachtransportunit.Thewithstandtemperatureofsleevesshallbeatleast5d egcentigrade more than maximum busbar temperature. The busbar temperatures shall be limited to the values indicated in the data sheet-A1 without forced cooling.

Busbarsshallbesupportedoninsulatorscapableofwithstandingdynamicstressesduetosh ortcircuit

OperatingMechanism Control

- Circuit breakers shall be operated by a motor spring charging type of mechanism. The mechanism shall be complete with motor, opening spring, closing spring and all accessories to make the mechanism a complete operating unit.
- Operatingmechanismshallnormallybeoperatedfromthebreakercubicle itself.
- The tripping spring shall be charged by the closing action, to enable quick tripping. Closing of the circuit breakershallautomaticallyinitiate rechargingof thesprings toenablethe mechanism to be ready for the next closing stroke. Charging time for the springs shall not exceed 30 seconds. It shall be possible to manually charge the springs in an emergency. Transfer from motor to manual charging shall automatically disconnect the charging motor. All operating mechanisms shall be provided with "ON" - "OFF" mechanical indication. The charging mechanism shall be provided with mechanical indicators to show "charged" and "discharged" conditions of the spring. Failure of any spring, vibration or mechanical shock shall not cause tripping or closing of the circuit breaker.
- Onlyone closingoperationof the circuit breaker shall result fromeach closingimpulse (manual or electrical), even if the breaker trips while the control device (manual or electrical) shall be being held in the "close" position.
- Thecircuit breakermechanismshall make one complete closingoperation, oncethe push button (PB) or control switch has been operated and the first device in the control scheme has responded, even though the PB or control

switch shall be released before the closing operation shall complete, subject to the condition that there is no counter-impulse for tripping.

- Means shall be provided to manually open and close the breakers slowly, when the operating power shall not be available, for maintenance and adjustments. A local manual trip device shall also be provided on the operating mechanism.

- Circuit breaker control shall be on 110V DC. Closing coils and other auxiliary devices shall operate satisfactorily at all voltages between 80 - 110% of the control voltage. Trip coils shall operate satisfactorily between 50 - 110% the rated control voltage.

SafetyInterlocksandFeatures

- Withdrawal or engagement of a circuit breaker shall not be possible unless it shall be in theopen position.
- All circuit breaker shall have lockable local / off / remote selector switch, for closing thebreaker from local shall be possible in both TEST / SERVICE position. Closing from remote shall be possible in either SERVICE and TEST position. For opening breaker from local shallbe possible only when local / off / remote selector switch shall be in local position. Opening breaker from remote shall be either breaker in service position or selector switch being inremote position.
- All MotorsandServiceTransformersfeeder breaker shall havelockableemergencypushbutton (openableonlywithkey)nearmotorandservicetransformer,hardwiredtocircuit breakerpanel emergency push button.
- Operation of a circuit breaker shall not be possible unless it shall be in service position, withdrawn to test position or fully drawn out. It shall not be possible to close the circuit breaker electrically in the service position, without completing the auxiliary circuit between the fixed and moving portions.
- Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationary isolated contacts when the breaker shall be withdrawn. Padlocking facilities shall be provided for locking the shutters positively in the closed position. It shall, however, be possible to open the shutters intentionally against spring pressure for testing purposes.
- The circuit breaker carriage shall be earthed before the breaker reaches the test position from fully withdrawn position. In case of breakers with automatic disconnecting type of auxiliary disconnects, the carriage shall be earthed before the auxiliary disconnects are made and the carriage earthing shall break only after the auxiliary disconnects break.
- Caution nameplate, “Caution Live Terminals” shall be provided at all points where theterminals are likely to remain live and isolation shall be possible only at remote end, i.e., incomer to the switchboard. Suitable interlock shall be wired for the purpose.

- The switchboard shall have passed internal arc testing for 1 second at the rated switchgear fault current. Pressure relief flaps shall be provided at the top of the switchboard with suitableexhaust arrangement to release hot over-pressurized gases in case of an internal fault. The internal arc time could be 0.5 sec or 0.1 sec at switchgear rated fault current in case rapid fault clearance time initiated by detectors sensitive to light, pressure or heat or by bus bar differential protection is provided.

Earthing

Copperearthingbusshallbeprovidedandextendedthroughoutthelengthoftheswitchboard.Itshall be bolted to the framework of each unit and brazed to each breaker earthing contact bar. It shall be located at the bottom of the board. The earth bus shall have sufficient cross section to carry the momentaryshortcircuitand shorttime faultcurrent for atleast1 second or higherwithout exceeding maximumallowabletemperature rise.The earthbusshallbe properlysupportedtowithstand stresses induced by the momentary short circuit current.

Suitable clamp type terminals at each end of the earth bus shall be provided to suit the size of the earthing conductors. Bolted joints, slices, tap, etc. to the earth bus shall be made with at least two bolts.Positiveearthingofcircuitbreakerframeshallbemaintainedwhenitshallbeintheconnected position and in all other positions whilst the auxiliary circuits are not totally disconnected.

Hingeddoorsshallbeearthedthroughflexibleearthingbraidofadequatecrosssection.Allnon- current carrying metal work of the switchboard shall be effectively bonded to the earth bus.

Positiveconnectionoftheframesofalltheequipment mountedintheswitchboardtotheearthbusbar shall be maintained through insulated conductors of size equal to the earth busbar or the load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to earth busbar bymeans of 1100V grade, green coloured,PVCinsulated,stranded,tinnedcopper,2.5sq.mmconductorloopedthrougheachofthe earth terminals.

Circuit/BusbarEarthingFacility

It shall be possible to connect each circuit or set of 3 phase bus bars of the switchboard to earth throughearthingswitches.Earthingswitches/earthingdevicesshallbemechanicallyinterlockedwith the associated breakers to prevent accidental earthing of live circuit or bus bars.

In case the earthing facility comprises earthing trucks to be inserted in place of circuit breakers, separate earthing trucks shall be supplied for each type / size of breaker. The earthing facilities proposed to be provided by the Bidder shall be clearly detailed in the Bid and shall be subject to Employer'sapproval.Auxiliarycontacts(min.2NO+2NC)shallbeprovidedoneachearthswitch/ earthing device and shall be wired to the terminal block for interlocking purpose.

Annunciators

Annunciators shall be of fascia type with translucent plastic window for each alarm point. Annunciated fascia plates shall be engraved in block lettering with respective alarm inscriptions. The inscriptionsshall be clearlyreadable and visible whentherespective fascia LEDlight shall belighted. EachannunciationwindowshallbeprovidedwithtwoLEDlightstoprovideredundancyagainstLED light failure. Lamps shall be replaceable from the front. Lamps shall be of clustered LED type.

All fascia annunciated points shall be suitable to accept external contactsof either ‘NO’ or ‘NC’ selforhandresettypeforinitiatingtheannunciationsequenceshallbesuitableforacceptingfleetingfaults of duration as less as 15 milliseconds.

For staticannunciator schemes, special precautionshall be taken bythe contractor toensurethat spurious alarm conditions do not appear due to influence of external magnetic fields on the annunciatorwiringandswitchingdisturbancesfromtheneighbouringcircuitswithinthepanels/ desks.

A “Lamp Test” push button shall be provided for each individual panel’s group of annunciators to limit the sudden drain on the battery. Provision of testing facilities for flasher and audible electronics alarmcircuitsofannunciatorsisdesirable.TheContractorshallgivethedetailsoftheofferedscheme.

Annunciatorshallhavefollowingfeatures:

- Suitableforannunciatingsubsequentfaultsimmediatelyafterthesoundcancelof the previous fault.
- During lamp test, if a fault occurs, the corresponding lamp circuit shall be automaticallydisconnected from the “lamp test” circuit and shall start flashing.
- Designed to prevent mal operation of the scheme or sequence when the push buttons arepressed incorrectly or in the wrong order.
- "AlarmSupplyFailure”Alarmschemesimilartothenormalannunciationsequencebut shall operate on a different DC supply or on AC auxiliary supply.
- Alarmannunciateshavingprovisiontointegrateallalarm/tripsignalstoPLC.
- Alarmannunciationshallbeprovidedfortransformers,Chlorinationsystemandsurge vessel system wherever discrete local automation shall be envisaged.
- AllAnnunciationsshallhaveinterfacingfacilitieswithcommunicationforSCADA.

IndicatingInstruments&Meters

Theinstrumentsshallbeelectronic/ digitaltypewithLCDdisplay.Theseinstrumentsshouldhave high performance ratio and can be equipped with digital output (for alarms) or with interfacing facilities for communication and remote reading of parameters.

- **MeteringInstruments**
- Multi-Function Meter with the facility to measure A, V, kW, kWh, kVAr, PF, kVARh, Hz and Hormonic (%THD) contents with communication port.
- Multi-Function Meters shall be of the accuracy class 1.0, suitable for measurement of unbalanced loads in three phase three wire circuits.
- MFM shall be suitable for operation from the secondary of CTs and VTs. They shall beprovided with a separate 3 phase 4 wire type test blocks for the testing of the meters without disturbing the CT and VT secondary

connections.

Theinstrumentscanbeelectronic/ digital typewithLCDdisplay&RS485connectivityforremote readingofparametersinSCADA.Theseinstrumentsshouldhavehighperformancer atioandcanbe equipped with digital output (for alarms).

ControlandSelectorSwitches

Control and instrument switches shall be heavy duty rotary type, provided with escutcheon plates clearlymarkedtoshowoperatingpositionandsuitableforsemi-flushmountingwithonlytheswitch front plate andoperatinghandle projectingout.The connections shall be fromthe back. The contact assembly at the back of the switch shall be enclosed in dust tight removable covers.

Thecontrol switchesshallbe3positions,springreturntoneutraltype.Theyshall beprovidedwith contacts to close in 'normal after close' and 'normal after trip' position. Each switch shall have external red and greenindicatinglamps, (except whendiscrepancytype switches are calledfor). In addition,asemaphoreindicatorshallbeprovidedforearthingswitch.Local/Off/ Remoteselector switch shall be stay put 2 / 3 position with lockable provision.

Contacts of the switches shall be spring assisted and contact faces shall be of silver / silver alloy.
Springsshallnotbeusedascurrentcarryingparts.Contactratingandconfigurationsof theswitches shall be adequate for the functions desired.

Lockable type switches, which can be locked in a particular position, shall be provided, if required. Emergencystopbuttons,ifany,shallincorporate'stay-put'featureswithindependentresetfacilities.

IndicatingLights/PilotLights

Indicatinglightshallberatedforoperationateither230V ACoratthespecifiedDCsystemvoltageas applicable. Lights shall be provided with translucent light covers.

ClusteredLEDtypelampsshallbeprovided.Lensesshallbeglassorplasticinstandard colours,red, green,blue,whiteandamber,inaccordancewithIEC 60073.Miniaturepilotlampsmaybeprovided with plastic markingplatecontainedinsidesquare(orrectangular) front lensto provide indication of legend or symbols engraved on the marking plate.

Thebasisofcolorsshallbeasfollows:

Red : Flow of energy.

Green : Noflowofenergy.

White : Supervisionofpoweravailable,relaycoilhealthy, etc.

Amber : For all alarm conditions such as pressure low, overload, Disagreement with originalcondition,'abnormal'conditionor'sequence-on'conditionalsoforserviceandtestposition.

Blue :

Forallhealthyconditionssuchascontrolsupply,spring charged and lockout relay coil healthy.

Yellow : ForR,Y,Bindicationlight,yellowasoneofthelights.

PushButtons

Pushbuttonsshallbeofmomentarycontacttypewithrearterminalconnections.Th ecolourofthe push button actuator shall be red for ‘OPEN / STOP’ and green for ‘CLOSE / START’.The push buttonknobshallbesuitablyshroudedtopreventinadvertentoperation.Thepushb uttonsshall be provided with integral inscription plates engraved with their designation.

Normal stoppushbuttonshallbemushroomtypelatchableinredcolour,after pressinganditshallbe latched, and latch can be removed by clockwise rotation (Motor stops automatically after predetermined conditions such as delivery valve close in case of pumps). This may replace stop push button.

Emergency stop push button red in colour shall be lockable by pressing the push button and can be openingonlywithkeyandwithshrouding. (Motorstoppedimmediatelyirrespectiveofpredetermined conditions required) Emergency Push button with shrouding shall be provided near transformer and motors for remote tripping.

Resetpushbuttonshall beeitherforresettingtheflagandOLRorLEDswithpushbuttonfor resetting.

All push buttons shall have independent, potential free, 2NO + 2NC contacts. The contact faces shall beofsilver/silveralloy.Thecontactsshallberated10Aandcapableofbreakinginductiv eloadof5A at 110V DC.

AllpushbuttonshallhaveadditionalNO/ NCpotentialfreeforhardwiringtoinstrumentationcontrol panel.

Space Heaters

Adequatelyratedanti-condensationspaceheatersshallbeprovidedforeachswitchboard/cubicle,bus ducts. Space heater shall beof the industrial strip continuous dutytype, ratedforoperation on a240V, 1 phase, 50Hz, AC system.

SpaceheatershallbeprovidedwithasinglepoleMCBwithoverloadandshortcircui trelease,a neutral link and a RTD thermostat to cut off the heaters at 35-degree C.

CubicleLighting/Receptacle

Each cubicle shall be provided with interior lighting by means of 18 W energy efficient (lumen per watt shall be indicated) LED lightingfixture. An MCB shall be provided for the lightingcircuit.The lightingfixtureshallbesuitableforoperationfroma240V,1ph,50Hz,ACsupply.A240V

,1phase, AC receptacle (socket) plug point shall be provided in the interior of each panel with an MCB.

Powerand ControlCable Termination

Terminals for power connections shall be complete with adequate phase segregating insulating barriers, shrouds and suitable aluminium solder less crimping type of lugs for terminating the cables and control cables lugs and ferrules shall be tinned copper confirming to IS 8309. The cable lugs for controlcablesshallbeprovidedwithinsulatingsleeveandshallsuitthetypeofterminationprovideon the equipment.

Double compression type glands with armour and bonding clamps for the termination of all solid dielectric multicore cables shall be provided and shall confirmto BS:6121. They shall be designed to secure the armour wires to provide electrical continuity between the armour and the threaded fixing component of the gland and to provide watertight seals between the cable outer sheath and gland and betweentheinnersheathandthreadedfixingcomponent.Theglandshallpreferablyprojectabovethe gland plate (non-magnetic material) to avoid entry of moisture.

Earthing connectors between cable armour and earth shall be routed outside the cable gland in an approvedmanner.Glandinsulationshallbecapableofwithstandingtestforappropriatehighvoltage for one minute.

CableterminationsforHV/MVcablesshallbeheat/coldshrinkabletype.Adequatelysized shrouds /boltsshallbeprovidedatconnectionstocompletelycoverthe terminations.

Wherecorebalancetypecurrenttransformersareprovidedonthefeedercablesforearthfault protection, glands for cables shall be insulated from earth in an approved manner.

WiringforControl andProtective Circuits

All lowvoltage wiringforcontrol,protection and indication circuitsshall be carried out with 1100V grade,PVCinsulatedcablewithstranded,tinnedcopperconductorofminimum1.5sq.mmsize.The size of conductor for CT circuits shall be minimum 2.5 sq. mm.

Allwiringshallberunonthesidesofpanelsandshallbeneatlybunchedandcleatedwithoutaffecting access to equipment mounted in the panel. The wiring shall be bound and supported by clamping, roughing or lacing. Spiral wrapping shall not be accepted. Wireways shall not be more than 50% full. Adequate slack wire shall be provided to allow for one re-stripping and reconnection at the end ofeachwire.Whenscreenedcablesorwiresarenecessary,aninsulatingsheathshallbeincluded.Wiring and supports shall be of fire-resistant material.

Wiringshallonlybejointedortiedatterminals.Terminalsoftheclamptypeshall nothavemorethan two wires connected.

TerminationandFerrules

Engravedcoreidentificationferrules,markedtocorrespondwiththewiringdiagram, shallbefittedto each wire and each core of multicore cables terminated on the panels.

Moistureandoilresistinginsulatingmaterialshallbeused.Theferrulesshallbeofthein terlocking type and shall grip the insulation firmly without falling off when the wire shall be removed.

Allwiresformingpartofatrippingcircuitshallbedistinctivelymarked.Spareauxiliaryc ontactsof electrical equipment shall be wired to terminal blocks.

ControlWiringTerminalBlocks

Terminalblocksshallbeof1000Vgrade,10Aandstudtype.Brassstudofatleast6mmdia .withfine threads shall be used and securely locked within the mounting base to prevent turning. Each terminal shallcomprisetwothreadedstuds,withalinkbetweenthem,washers,andmatchingnu tsandlocknuts for each stud. Connections to the terminals shall be at the front.

Terminalsshallbenumberedforidentification,groupedaccordingtofunction.Engrav ed‘blackon- white’ labels shall be provided on the terminal blocks describing the function of the circuit.

Terminalsforcircuitswithvoltageexceeding110Vshallbeshrouded.Terminalblocksa tdifferent voltages shall be segregated into groups and distinctively labelled. Terminals used for connecting current transformer secondary leads shall be ‘disconnecting and shorting’ type with a facility for earthing the secondary.

Terminal blocks shall be arranged with 100 mm clearance, between any two sets. Separate terminal stemsshallbeprovidedforinternalandexternalwiringrespectively.Allwiringshallbet erminatedon terminal blocks, using crimping type lugs or claw type of terminations.

At least 20% cores shall be kept spare in multicore control cables. At least 10% spare terminals shall beprovidedandspaceforaddinganother10%sparesterminalsshallalsoavailableinea chset ofTBs.

BusBars

The Bus bars shall be of electrical grade, high conductivity, copper and shall be provided with minimum clearances as per relevant IS. Bus bar cross section shall be uniform throughout the length oftheswitchgear.Allbusbarsandbustapsshallbeinsulatedwithclosefittingsleeve ofhard,smooth, dust and dirt free,heat shrunkPVC insulation ofhigh dielectric strength, to provide a permanent non- ageing and non-tracking protection, impervious to water, tropical conditions, and fungi.

Theinsulationshallbenon-inflammableandself-extinguishingtypeandinfastcolourstoindicate phases. The dielectric strength and properties shall hold good for the temperature range of 0 to 95 degree centigrade. If theinsulatingsleeve isnotcolour,bus bars shall be colourcoded

with colour PVC tape at suitable intervals for easy identification.

Busbar joints shall be of the bolted type. Spring washers shall be provided to ensure good contact at thejoints.Busbarsshallbethoroughlycleanedatthejointsandsuitablecontactgreases hallbe applied just before making a joint. Direct access to, or accidental contact with busbars and primary connections shall not be possible.

Allaperturesandslotsshallbeprotectedbybafflestopreventaccidentalshortingofbusbarsdueto insertion of maintenance tools.

Sequenceofred,yellowandbluephasesandneutralforfour-poleequipmentshallbelefttorightand top to bottom, for horizontal and vertical layouts respectively.

EndterminationsattransformerendandMVpanelendshallbeflexiblebusbarsuchthatnoload/ force / weight of the bus bar act on the terminal studs.

Current&Voltage Transformers

Current transformers shall be of cast resin, bar primary type unless specified otherwise, suitable for continuousoperationattheambienttemperatureprevailinginsidetheswitchgearenclosureandshall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block. The class of insulation shall be Class E or better.

Currenttransformersshallbeabletowithstandthethermalandmechanicalstressesresultingfromthe maximum short circuit and momentary duties of the switchgear. For wound primary type CTs, the short time current rating shall not be less than 0.5 sec. CT core laminations shall be of high-grade silicon steel. Where multi ratio current transformers are specified, a label shall be provided, clearly indicating the connections required for the alternative ratios.

These connections shall also be shown on panel wiring diagrams. Identification labels shall be fitted giving type, ratio, rating, output and serial numbers and duplicate rating labels are to be fitted on the exteriorofthemountingchamberssuitablylocatedtoenablereadingwithouttheremovalofanycover or metal sheeting forming part of the structure of the switchboard.

Magnetizationcharacteristicscalculatedperformanceandprotectivesettingsshallbeprovidedbythe contractor.AllVoltageTransformersshallbeofSingle-Phasetype.ThebusVTsshallbehoused ina separate panel in a truck so as to be fully with drawable. All Voltage transformers shall have HRC fuses / MCBs on Primary and MCBs on Secondary Side. There shall be provision for changeover on secondary side of Voltage Transformers to have alternate arrangement in case one Voltage Transformer fails.

Relays

(o) All Protective relays shall be numerical type except aux. relays. Numerical relays shall have appropriate settingranges, accuracy, resettingratio,transient overreach and othercharacteristics to provide required sensitivity.

(p) All numerical protective relays shall be flush mounted at the front with connections at the rear. Shall have communication port for remote,

metering and monitoring facility, suitable for electrical measurement including voltage, current, power (active / reactive) and energy parameters.

(q) All numerical relays shall have keypad to allow relay settings from relay front. Resetting knobs shall be accessible from the front on removing the external cover and shall be external to the case.

(r) All numerical relays and timers shall be rated for control supply voltage specified and becapable of satisfactory continuous operation between 70 % and 110 % of the rated voltage. Making, Carrying and Breaking Current ratings of the relay contacts shall be adequate for the circuits in which they are used.

(s) The numerical relays shall have communication, metering and monitoring facility. The communication facility shall have two Ports local front port (RJ45/USB) for laptop communication and the second port Rear RS485 for SCADA.

(t) The numerical processor shall be capable of measuring and sharing values of a wide range of quantities, events, faults and disturbance recordings with time stamping using internal real time clock. Battery backup for real time clock in the event of power failure shall be provided.

(u) Numerical Relays shall have diagnostic feature with self-check for power failure,Programmable routines, memory and main CPU Failures etc.

(v) The Protective relays shall have adequate number of potential free contacts (Programmable). The Contacts shall be suitable for directly wiring in the breaker closing and tripping circuits operating from 110V DC Control Voltage.

(w) The current operated relays shall have provision for 4 Sets of CT Inputs and Voltage operated relays shall have provision for 3 PT inputs. Relays shall be suitable for CT secondary current suitable for CT Secondary current of 1A / 5A selectable at Site.

(x) Numerical Relays shall be immune to any kind of electromagnetic interference and capacitance effect due to length of connected control cables.

(y) TimerfunctionshallbeprogrammableforON/OFFdelays.

(z) Numerical Relays shall be able to provide supervisory function such as trip circuit monitoring, circuit breaker monitoring, PT & CT supervisions and recording facilities with post fault analysis.

(aa)All relaysshallwithstandminimumtestvoltageof2kVACRMSforone minute.

(bb)Numerical relays shall have two level password protections, one for read only and other for authorization for modifying the setting etc.

Energymonitoringandpowersupplymanagement

Necessary provisions & features shall be incorporated to enable energy monitoring / energy managementfortheinstallation.EnergyMeteringshallmeettherequirementofguaranteedspecific energy consumption specified by the contractor through instrumentation control system.

Incase,Numericalrelayshavingbuiltinfeaturesofenergymeasurementofrequisiteaccuracyand provided in switch gear, separate energy meter shall not be required.

Necessaryprovision&featuresshallbeincorporatedtoundervoltagemonitoring/ relayforincomer feeder, busbar chamber and control supply.

I/ OsignalforInstrumentation,Control&AutomationSystemfrom Electrical panels.

I/ Osignalsfrominstrumentsshallbeseparatelywiredtoamarshallingboxsuchthatinstrumentation engineers shall not enter into power panel that are not familiar with them.

Necessaryprovisionsshallbeincorporatedtomeettherequirementsindicatedin:

(d) I/OSchedules–ACB/ VCB,CommandOpen&Close,Feedbacktrip,Breakerhealthy (Ready to close), Local / Off / Remote, Breaker Opened / Closed, Breaker Test / Service Position.
(e) DataTransfer Schedule
(f) Alarm Schedule of Particular requirement of Instrumentation, Control & Automation System, Part-13, and Volume 2 of the Bid document.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

415VMetalEnclosedSwitchgears(PCC/MCC)

415VMetalEnclosedSwitchgear(PCC/ MCC)systemshallhaveprovisionsuchthatinter-operaabilitywithinstrumentationcontrolssystem.MCC/PCCpanelboardsshallbeofferedforfinal inspection at the OEM’s works with routine tests.

ApplicableStandards

Theswitchgearandcomponentsshallconformtothelatestapplicablestandardsspecified below.

SwitchgearGeneralRequirements	IS:13947/BS:5486/ IEC:60947
FactoryBuiltAssembliesofSWGRandControlgearfor Voltages up to and including 1000V AC & 1200V DC	IS:8623/BS:5486/IEC:60439-1
AirCircuitBreakers(ACB)	IS:13947-Part(1&2)/BS EN:60947 / IEC:60947
Low-voltageSwitchgearandControlgearassemblies	IEC:61439–1&2

MouldedCaseCircuit Breaker	IS:2516 / IEC 60947-2 / BS EN:60947-2/IS:13947-Part(1&2)

MiniatureCircuitBreakers	IS:8828/ BSEN:60898
Lowvoltage Fuses	IS:13703/BS:1362/ IEC:60269-1
Contactors	IS:13947/BSEN60947-4/ IEC:60947 -1
Starters	IS:13947/BSEN60947–4/ IEC:60292-1to4
ControlSwitches/Pushbuttons	IS:6875/ BSEN60947
CurrentTransformers	IS:2705/ BS:7626
VoltageTransformers	IS:3156/BS:7625/IEC:60044, 60186
Indicatinginstruments	IS:1248/BS:89/ IEC:60051
Electricalrelays.	IEC:60255
MarkingandIdentificationofConductorsandApparatus Terminals	IS:11353/BS:159
A.C.ElectricityMeters	IS:722,8530/BS:5685/ IEC:60145, 60211
Degreeof Protection	IS:13947/IEC:60947- P1
Selectioninstallationandmaintenanceofswitchgearand control gear	IS:10118
Codeofpracticeforphosphatingcoatedironandsteel	IS:6005/ BS:3189
Specificationforcopperrodsandbarsforelectrical purposes	IS:613
Controltransformersforswitchgearandcontrol gear voltage not exceeding 1000V AC	IS:12021
ClassificationofHazardousareashavingFlammable gases and vapours for Electrical Installation	IS:5572
GuideforSelectionofElectricalEquipmentfor Hazardous areas	IS:5571
Electricalapparatusforexplosivegasatmospheres- General Requirements	IEC:60079

BasicandSafetyPrinciplesforMan-MachineInterface, Marking and Identification - Coding Principles for Indicators and Actuators.	IEC:60073
ConductorsofInsulated Cables.	IEC:60228
Dimensions of low-voltage switchgear and Control gear. Standardizedmountingonrailsformechanicals upportof electricaldevicesinswitchgearandControlgear installations.	IEC60715
Graphicalsymbolsforuseon equipment.	IEC:60417
Electricitymeteringequipment	IEC:62052-11/IEC62052-21
Emptyenclosuresforlow-voltageswitchgearandControl gear assemblies General requirements and Control gear assemblies General Requirements	IEC:62208

General

The LV switchboards shall be type tested assemblies (TTAPanels) inall respectsbe suitable for operationsinserviceconditionsandwithstandingthestressestotheseismicconditions.Theoffered designshallmeettherequirementsofIEC60068-2-57,&IEC60068-3-3.Necessarytypepestreport fromanindependentinternationallyaccreditedtestlaboratoryshallbefurnishedto establishthatthe offereddesignperformssatisfactorilyincompliancetothereferencestandards.

The LV switchboards shall be type tested assemblies (TTA) fully meeting the requirements of IEC 61439 – 1 & 2 for design verified assemblies. The eligible switchboard suppliers shall be Original EquipmentManufacturer(OEM)onlywiththeirownrangeofACBs,MCCBs,PowerContactors& otherswitchgeardevices.Theswitchboardsshallbe manufactured,design&testedbyOEMattheir own works.

The LV main switchboards and the associated equipment, including switchgear, control gear and bus bar assemblies shall be certifiedfor the categoryof dutyspecified. TheLV MainSwitchboard shall be identical in mechanical construction to the LV Switchboard which had been type-tested by an acceptable,multifolddesignforstructuralmembers(9-folddesign)withimpacttestasperIEC62262, accredited and independent testing laboratory for the fault conditions, temperature rise limits. Any manufacturer not having the above will not be considered for supply. The main circuits ofthe LVmain switchboards shall have an insulation voltage of 1000 V AC. Panels shall be tested to withstand internal arc fault of 50kA, 0.4 seconds and valid Type Test Certification shall be provided as per IEC61641.

Thedesigntemperatureforthe equipmentprovidedinthemainlowvoltageswitchboardssh allbe+45
^{0}C.Therelativehumidityshallbe75%atatemperatureof+45^{o}C.

Wherearmoured multicore cables terminate inside theswitchboardenclosure,glandingplatesor glanding brackets shall be provided for securing the cables to the switchboard. Glanding plates,

glanding brackets and extension boxes shall be removable and shall be of adequate size for the particularcablestobeterminated.Separatecurrenttransformersshallbeprovidedfor each protection device and for instrumentation. The switchgear assembly/ sub-assemblies or panels shall be termite and rodent proof. The sub-assemblies of similar equipment shall be interchangeable.

Switchboards(TTA) shallalsohaveSeismicwithstandcapability.

The offered switchboard along with Incomer ACBs / MCCBs and outgoing feeders with all interconnections shall be as per type tested design of OEM at CPRI / ERDA / Independent internationaltesthouseforshortcircuit,temperaturerise,protectiveearthshortcirc uittestand dielectric tests of the ratings required.

ForoperatorsafetyIP2X(touchproof)protectiontobeavailableevenafteropeningthe feeder compartment door.Thecompartmentalizationtobeachievedbyusing metalorFRPseparators,useof PVC sheet / Hylem sheets shall not be allowed.

TheSwitchboards shallbeof adequatesize with a provisionof sparespace toaccommodatepossible future additional switch gear.

FeaturesofConstructions

(o) Theswitchgearshallbemetalenclosed,dustproof,modulartype,suitableforindo orfloor mounting and shall have following features:
  (ix) Total height of switchgear shall not exceed 2300 mm. Height of Switches, push buttons shall not exceed 1800 mm and shall not be less than 600 mm.
  (x) Shallbesinglefrontexecutionandfixedtype.
  (xi) Shallhavedesignationlabelsbothonfrontandrear sides.
  (xii) Shall be provided with proper gasketing for removable covers, doors, between panels and base frame and all around the perimeter of adjacent panels.
  (xiii) DegreeofProtectionshallbeIP54forindoor&IP65for Outdoor.
  (xiv) ThicknessofCRCASheetthepaneldoorsshallbe2.5mmoroverandforthere stshallbe 2.0mm.
  (xv) Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidec overs.
  (xvi) ShallfollowIS5572/ IEC60079,standardspecificationandstandardpracticefor installation in Hazardous area.

(p) Switchgearshallbedividedintodistinctverticalsectionseachcomprising:
  (xiv) Acompletelyenclosedbusbarcompartmentrunninghorizontally.
  (xv) Enclosedverticalbusbarsservingallmodulesinvertical section.
  (xvi) Aseparatehorizontalenclosureforallauxiliarypowerandcontrolbuses,if required.
  (xvii) Verticalcablealleyof250mmwidecoveringentireheight.
  (xviii) Operatingdevicesshallbeincorporatedonlyinthefrontofswitchgear.
  (xix) Eachshippingsectionshallhavemetalsheetsatbothends.
  (xx) Cablealleyshallbeprovidedwithsuitablehingeddoors.

(xxi) GSEarthbusofsize50mmx10mmshallbeprovidedatthebottom.
(xxii)Alldoorsshallbewithconcealedtypehingesandcaptivescrews.
(xxiii) Each vertical section shall be equipped with 240V, 1Phase, 50Hz space heater controlled by thermostat.

(xxiv) A 240V, Phase, AC plug point shall be provided in the interior of each cubicle with on-off switch for correction of head lamps.

(xxv) 20% spare feederswith at leastone for each typeof highestrating shallbeprovidedin each switchgear.

(xxvi) Interchangeability- Allidenticalequipmentandcorrespondingpartsbefully interchangeable without any modifications.

(q) MainandAuxiliaryBuses

(viii) Switchgear busbars shall be of uniform cross section throughout the length and made of high conductivity, electrical grade hard drawn copper conductor with 1.40Amp / Sq.mm current density throughout the length.

(ix) All busbars shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non- ageing and non-tracking protection, impervious to water, tropical conditions and fungi.

(x) Busbar joints shall be provided with contact grease at the joints and shall be complete with tensile steel bolts and belleville washers and nuts.

(xi) All sheet steel work shall be phosphate coated in accordance with the followingprocedure and in accordance with IS: 6005 “Code of Practice for Phosphate coated Iron and Steel”. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

(xii) After phosphate coated, thorough rinsing shall be clean water followed by final rinsing with dilute dichromate solutionand even drying. The phosphate coatingshall be followed by the application of two coats of ready mixed stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved. After application of the two coats of primer finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests. The final finished thickness of paint film on steel shall not be less than 80 microns and shall not be more than 120 microns.

(xiii) Finished painted surface of panels shall present an aesthetically pleasing appearance free from dents and uneven surface.

(xiv) Asmall quantityoffinishingpaint shall be suppliedforminortouchinguprequiredat site after the installation of the panels.

(r) The equipment shall be arranged within each compartment such that all normal maintenance canbecarriedoutthroughhingedaccessdoorsorremovablecovers,andwherepossible from the front. The switchboard shall have a rated shorttime withstand currentas per SLD andafaultwithstandforasupplyvoltageof(415V)AC between phases at 50Hz.

(s) Protection against shock in normal service shall be achieved by the provision of barriers or enclosures both vertical and horizontal and between adjacent units to ensure segregation and prevent accidental

contact with live parts, or by complete insulation of all live parts. Control cables shall be segregated from primary conductors.

(t) Switchboard construction shall employ the principle of compartmentalized and segregationfor each circuit.

(u) Incomerandbussectionpanelsorsectionsshallbeseparateandindependentand shallnot be wired with sections required for feeder

(v) Switchboard shall be readily extensible on both sides by addition of vertical sections after removal of the end covers.

(w) Special care to be taken to ensure effective earthing of the frame and doors of the switchboards. All metallic parts shall be effectively connected a protective earth system in the switchboard to ensure positive earthing at all times.

(x) Allpanelsandcoversshallbeproperlyfittedandsquarewiththeframe.Theholesin the panel shall be correctly positioned.

(y) Switchboard shall be provided with “Danger Notice Plate” conforming to relevant Indian Standards.

(z) TheLVswitchboardsshallbemountedonarobustbaseframemadeupofsteelchannelswitha minimum height of 100mm. The base frame shall be able to withstand thestatic and dynamicloads oftheLVswitchboards.Thesteelchannelsshallbepaintedwithepoxy polyster paint.

(aa)Forcompartmentalizedswitchboards,separatetotallyenclosedcompartmentsshallbe provided for horizontal busbars, vertical busbars, ACBs, MCCBs, and cable alloys.

(bb)Cablecompartmentsshallbeof adequatesizeforeasyterminationofallincoming and outgoing cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

AirCircuitBreaker (ACB)

(u) Aircircuitbreakershallbeselectedforfeedersforloadcurrentmorethan630A.

(v) Circuit breakers shall be operated by a motor spring charging type of mechanism. The motor operated spring charged mechanism shall be complete with motor, opening spring, closing spring and all accessories to make the mechanism a complete operating unit.

(w) The tripping spring shall be charged by the closing action, to enable quick tripping. Closing of the circuit breakershallautomaticallyinitiate rechargingof thesprings toenablethe mechanism to be ready for the next closing stroke. Charging time for the springs shall not exceed 30 seconds. It shall be possible to manually charge the springs in an emergency.

(x) Transfer from motor to manual chargingshall automaticallydisconnect the charging motor. The charging mechanism shall be provided with mechanical indicators to show "charged" and "discharged" conditions ofthe spring. Failure of anyspring, vibration or mechanical shockshall not cause tripping or closing of the circuit breaker.

(y) Onlyone closingoperationof the circuit breaker shall result fromeach closingimpulse (manual or electrical), even if the breaker trips while the control device (manual or electrical) is being held in the "close" position.

(z) Thecircuit breakermechanismshall makeonecompleteclosingoperation,oncethepushbutton has been operated and the first device in the control scheme has responded, even though the PB shall be released before the closing operation shall be completed, subject to the condition that there is no counter-impulse for tripping.

(aa)Means shall be provided to manually open and close the breakers slowly, when the operating power shall not be available, for maintenance and adjustments. A local manual trip device shall be provided on the operating mechanism.

(bb)Alloperatingmechanismsshallbeprovidedwith"ON"-"OFF"-"TRIP"mechanical indication.

(cc)Closing coils and other auxiliary devices shall operate satisfactorily at all voltages between 85 - 110% of the control voltage. Trip coils shall operate satisfactorily between 70 - 110% the rated control voltage.

(dd)The ACB shall be 4 pole with modular construction, draw out, manually operated. In case of 4 pole version neutral rating shall be 100% of phase.

(ee)The Breaker shall be provided with Microprocessor based Protection unit for Inverse-time delayed overload releases for the phases, Short-time delayed short-circuit releases and earth- fault releases.

(ff)The breaker service Short Circuit breakingcapacity(I_{CS}) shall be equal to ultimate Short Circuit capacity (I_{CU}) and shall be equal to short time withstand current of Breaker (I_{CW}).

(gg)ACB shall be provided for Incoming side of the PCC / MCC from transformer irrespective of rating of feeder.

(hh)The cradle shall besodesignedandconstructed astopermitsmoothwithdrawal andinsertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls / rollers and not on flat surfaces.

(ii) There shall beprovision for locking the breaker inany of Service, Test orIsolated positions.

(jj)ACBshallbesuppliedwith4auxiliarycontacts(combinationsofNO/ NCshallbeselectedat site)and 1 tripcontact.Ifneed arise there shall be facility toadd additionalauxiliary contacts (6 no's).

(kk) ACBshallhaveprovisiontouse`ReadytoClose'contact.

(ll)

Thesafetyshuttershallpreventinadvertentcontactwithisolatingcontactswhen breakeris withdrawn from the Cradle.

(mm)ArcChutecoverswherevernecessary shallbe provided.

(nn)ACB shall have a Ready to close indication contact which shall be used to give a singleindicationviaindicatinglampsonpanel doorifACBisreadytobeclosed,aftercheckingall the given conditions ensuring safety for user and electrical distribution.

IntelligentMotorProtectionRelay

The intelligent motor controller for 3-phase AC induction motors combining the two classical functions of motor protection and motor management in a single device plus offering diagnostic and fieldbuscommunication.Thedevicefunctionsshallbeadjustedinawiderangetocover theneedsof different applications.

ProtectionFunctions:

Itshallbeprovidedmotorprotectionincludingphasefailuredetection,adjustablemoto rprotectionfor stalled motors during start up or normal operation, configurable current limits to generate trips or warnings with following features:

(f) Overloadclasses.
(g) Thermistormotorprotection(PTC).
(h) Earthfaultdetection.
(i) Powerandvoltage-basedprotectionfunctions.

(j) Supervisionofthenetworkquality(TotalHarmonicDistortion)

FieldBusCommunications:

(d) It shall be integrated into different fieldbus networks such as PROFIBUS DP, Device Net MODBUS and CAN open via the Fieldbus Plug interface. All measured data, status signals and parameters shall be accessed via fieldbus.
(e) Itisalsopossibletousetheasastand-alonedevicewithouttheFieldbusPlugcommunication.
(f) Themotorprotectionandmotormanagementisfullyfunctionalintheeventofabus failure

Parameterisationoftheprotectionandcontrolfunctionscanbecarriedoutwiththedevicedescription files as defined by the different fieldbuses (e.g. GSD for PROFIBUS). In addition, a Device Type Manager (DTM) offering a very convenient device configuration via a laptop or within a control system is required.

MotorManagement,InputsandOutputs

It shall be provided six digital inputs, three relay outputs and one 24 V output. Therefore, a wide number of control functions shall be covered from the base device. If further inputs or outputs are needed, the basic device can be expanded with an expansion module. The relay shall be supported standard configurations are direct starter, reversing starter, star-delta starter, actuator, inching mode andmanymorefeatures.Toexecutecustomerspecificapplications&allowsfreeprogrammingofits internal logic.

Differentcontrolstations(DCS,DI,andOperationPanel)withindividual,adjustablerelease opportunities are required.

Metering,MonitoringandDiagnosis

Rapid, comprehensive diagnostics and operating status information shall be available on the on the LCDpanel(cleartextmessages),viafieldbusoronalaptopconnecteddirectlyorvia fieldbustothe relay.

Thefullygraphic,multi-languageLCDpanelallowsconfiguration,controlandmonitoringofthe controller and its inputs and outputs.

Availablediagnosisincludesmotor,busanddevicestatus,maintenancecounterssuchasnumberof starts and overload releases, remaining cooling time, etc.

MouldedCaseCircuitBreaker(MCCB)

All MCCB’s shall be of the air break, quick make, quick break and trip free type switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCB’s shall be capable of Variable

overload adjustment.

MCCBs shallhave an ultimateshort circuit capacitynot lessthantheshortcircuitcurrent Specified. MCCBsshallhaveaserviceshortcircuitbreakingcapacity(I_{CS})isequaltotheultimate short-circuit capacity (I_{CU}).

EachpoleofMCCBshallbefittedwithabi-metallicthermalelementforinversetimedelayprotection and a magneticelementforshort circuit protection. Alternatively, theyshall befitted with a solid-state protection system. Such a protection system shall be fully self-contained, needing no separate power supply to operate the circuit breaker tripping mechanism.

Thermalelementshallbeadjustable.Adjustmentsshallbemadesimultaneouslyonall polesfroma common facility. Thermal elements shall be ambient temperature compensated.

Electronic/ MicroprocessorTripUnitshallbeequippedwithinternalbatterytopowerthedisplayi n no load conditions.

TheMCCBsshallbeprovidedwiththefollowingfeatures:

- Commontripbarforsimultaneoustrippingofallpoles.
- Shrouded terminals.
- Timeforclearingshortcircuitcurrentof20 msec.
- 2 NO + 2 NC auxiliary contacts suitable for switching 24V DC, 10mA PLC Signals with noloss of signal integrity.

MCCBsshallbeactuatedbyanextendedrotary-handlewithpadlockarrangementthatclearly indicates the three distinctive positions: ON, OFF and TRIPPED.

Adjustableoverloadreleasesforthephases,AdjustableShort-timedelayedshort-circuitreleasesand earth-fault releases. Rotary operated mechanism 240V AC Shunt trip Coil has to be provided.
Manually closing mechanism should be accommodated in a Moulded housing of robust and vermin- proof construction.

MCCB shall be provided with double insulation (insulation between front cover and internal power circuits to avoid any accidental contact with live current carrying path with the front cover open). The insulating case shall be made of high strength heat resistant and flame retardant thermosetting insulating material.

Switches

415Vair-breakswitchedshallbeoftheloadbreak,faultmake,groupoperatedtype.Foruseon 3- phase systems, the switches shall be of the triple pole type with a linkfor neutral wire. For use on single phase system, the MCB type switches shall be of the two-pole type.

(i) Switches shall be of the heavy duty, quick make and quick break type. Switch contacts shallbe silver plated, and contract springs shall be of stainless steel. Switch handles shall have provision for locking in both

fully open and fully closed positions. Mechanical ON - OFF indication shall be provided on the switches.

(j) Switchesforcontrollingmotorcircuits shallbe oftheloadbreak, faultmake type, andshallbe capable of breaking locked rotor current of the associated motor.

(k) 415Vswitchesandfusesshallbeprovidedwiththefollowinginterlockssothat.

(l) Thefusesarenotadvisableunlesstheswitchshall beinfullyopencondition.

(m) It shall not be possible to close the switch when the cover shall be open, but an authorized person may override the interlock and operate the switch. After such an operation, the cover shall be prevented from closing if the switch shall be left in the 'ON' position.
(n) Fuse less system shall be provided in case fuses required, fuses shall be of the HRC cartridge type, mounted on plug-in type of fuse bases. Fuses shall be provided with visible indicators to show that they have operated.
(o) Earthing and neutral lines in main supply circuits shall be of solid silver-plated copper and be of the bolted pattern.
(p) Fusesandlinksfunctionallyassociatedwiththesamecircuitshallbemountedsidebyside.

MiniatureCircuitBreaker(MCB)

MCBshallbehandoperated,airbreak,quickmake,quickbreaktype. Operatingmechanismsshallbe mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions.

Eachpoleshallbefittedwithabi-metallicelementforoverloadprotectionandamagnetic elementfor short-circuit protection. Multiple pole MCBs shall be mechanically linked such that tripping of one polesimultaneouslytripsalltheotherpoles.Themagneticelementtrippingcurrentclassificationshall be of the type suitable for the connected load. Where this shall not be specified, it shall be Type C. The short circuit rating shall be not less than that of the system to which they are connected.

Contactors

The power contactors used in the switchboard shall be of, air break, single throw, triple pole, electromagnetictype.Contactorsshallbesuitableforuninterrupteddutyandratedfor ClassAC3duty in accordance with the latest edition of IS 13947.

Operating coils of all contactors shall be suitable for operation on 240V, single phase, 50Hz supply.
ContactorsshallbeprovidedwithatleasttwopairsofNOandNCauxiliarycontacts.Contactorsshall not drop out at voltages down to 70% of coil rated voltage.
Contactors shall be provided with a three element, positive acting, ambient temperature compensated, time lagged, hand reset type thermal overload relay with adjustable settings. The hand reset button shall be flush with the front door of the control module and shall be suitable for resetting the overload relay with the module door closed.
Relays shall be either direct connected or CT operated. Overload relay and reset button shall be independentofthe"Start"and"Stop"pushbuttons.Allcontactorshallallbeprovidedwithsingle phasing preventer (SPP).

Motorstartersshallbecompletewithauxiliaryenergymeters,protectiverelays,timersand necessary indications such that inter-operability with the instrumentation system.

CurrentTransformers/ CBCT

(f) CurrentTransformersshallbeCastResin type.
(g) Currenttransformersshallhave polaritymarkingsindeliblymarkedoneachtransformerandat the lead terminations at the associated terminal block.

(h) Current transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary duties of the switchgear, as indicated in the Technical Specification.

(i) CTcorelaminationsshallbeofhigh-gradesiliconsteel.

(j) Identificationlabelsshallbefittedgivingtype,ratio,rating,outputandserial numbers.

IndicatingInstruments&Meters

Allindicationinstrumentsandwatthourmetersshallbeofthedigitaltypeandshallhave anaccuracy of Class 1.0. Digital type ammeters, voltmeters and multifunction energy meters shall have communication port RS485.

IndicatingLights

IndicatinglightsshallbeoftheclusterLEDtype,withlowwattconsumption.Indicatingl ampshallbe rated for operation at either 240V AC or at the specified DC system voltage as applicable. LED shall be provided with translucent lamp covers. Bulbs and lenses shall be interchangeable and easily replaceable from the front.

Push Buttons

"Start"and"Stop"pushbuttonsshallbecolouredgreenandredrespectively.StopPus hButtonshall be lockable stay-put type with Mushroom head without key or Emergency push button lockable in OFF position and open able only with key.

SpaceHeaters

Adequately rated anti-condensation space heaters shall be provided, one for each control panel, for each switchboard and for each marshalling kiosk. Space heater shall be of the industrial strip continuous duty type, rated for operation on a 240V, 1phase, 50Hz, AC system. Each space heater shallbeprovidedwithasinglepoleMCBwithoverloadandshortcircuitrelease,aneutr allinkanda control RTD thermostat to cut off the heaters at 35 Deg. C.

Safety Arrangements

Allterminals,connectionsandothercomponents,whichmaybe“live”whenfrontaccess door shallbe open, shall be adequately screened. It shall not be possible to obtain access to an adjacent cubicle or module when any door shall be opened. Components within the cubicles shall be labelled to facilitate testing.

Earthingof Switchboards/Panels

Eachswitchboard,controlpanel,etc.shallbeprovidedwithanearthbusbarrunningal ongitsentire length. The earth bus bar shall be located at the bottom of the board / panel.

Earthbusbarsshallbeofcopperandshallberatedtocarrytheratedsymmetricalshortci rcuitcurrent of the associated board / panel for one second, unless otherwise

specified. Earth bus bars shall be

properlysupportedtowithstandstressesinducedbythemomentaryshortcircuitcurrentofvalueequal to the momentary short circuit rating of the associated switchboard / panel.

Positiveconnectionoftheframesofalltheequipmentmountedintheswitchboardtothe earthbusbar shall be maintained through insulated conductors of size equal to the earth bus bar or the load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to earth bus bar by means of 1100V grade, green coloured,PVCinsulated,stranded,tinnedcopper,2.5sq.mmconductorloopedthroughthecaseearth terminals.

InternalWiring

The internal wiring shall be carried out with 650 / 1100V grade, PVC insulated, stranded conductor wires.Theminimumsizeofconductorforpowercircuitsshallbe4Sq.mmcopperconductor.Control circuits shall be wired with copper conductor of at least 1.5 Sq.mm.

I/OforInstrumentation,Control&AutomationSystemfromElectricalpanels.

I/O signals from instruments shall be wired to marshalling box of MCC / Switch gear such that instrumentationengineersshallnotenterintopowersystempanelthatarenotfamiliarwiththem. Necessary provisions shall be incorporated to meet the requirements indicated in:

(d) I/O Schedules – ACB / VCB, Command Open & Close, Feedback trip, Breaker healthy(Ready to close), Local / Off / Remote, Breaker Opened / Closed, Beaker Test / Service position feedback.
(e) DataTransfer Schedule.
(f) Alarm Schedule of Particular requirement of Instrumentation, Control & Automation System, Part - 13, and Volume 2 of the Bid document.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc. shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

PowercapacitorandAPFCcontrolpanel(415V)

ApplicableStandards

The capacitor and control panel conform to the latest applicable standards specified below. In case of conflict between standards and this specification, this

specification shall govern.

Shuntcapacitorsforpowersystems	IS:13585,IS: 13340
Internalfusesandinternaloverpressuredisconnections forshunt capacitors - Specification	IS: 12672
Metalenclosedswitchgear	IS/IEC60947/ BSEN60298/ IEC:60298
Codeofpracticeforphosphatecoatedironandsteel	IS:6005/BS: 3189
Specificationforcopperrodsandbarsforelectrical purpose	IS:613

DesignFeatures

(p) The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not.

(q) The capacitor bank shall be complete with the required capacitors along with the supportingpost insulators, steel rack assembly, copper bus bars, copper connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.

(r) The capacitor bank may comprise of suitable number of single-phase units in series parallel combination. However, thenumber of parallel units ineach ofthe seriesracks shall be suchthat failure of one unit shall not create an overvoltage on the units in parallel with it, which shall result in the failure of the parallel units.

(s) The complete capacitor banks with its accessories shall be metal enclosed (in sheet steel cubicle), indoor floor mounting and free-standing type.

(t) Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidecovers.

(u) All sheet steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate coated and then painted with two coats of zinc rich primer paint. After application of primer, two coats of finishing synthetic enamel paint oven baked / stove shall be applied.

(v) The assembly of the banks shall be such that it provides sufficient ventilation for each unit. Necessary exhaust fan, louvers with filters must be provided in the cubicle to ensure proper ventilation for heat dissipation.

(w) Each panel shall be provided with 240 Volts, 1 phase, 50Hz, 5amps, 3pin receptacles with switch located in a convenient position. An interior illuminating CFL / LED lamp together with the operating door switch and protective fuses shall be provided.

(x) Each capacitor unit / bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute in accordance with the provisions of the latest edition of IS: 2834.

(y) Capacitors shall be of Mixed Dielectric of polypropylene and paper with internal element fuses. The impregnate shall be non-PCB (poly chlorinated biphenyl) oil.

(z) Each unit shall satisfactorily operate at 135% of rated KVAR including factors of overvoltage, harmoniccurrentsandmanufacturingtolerance.Theunitsshallbecapableofcon tinuously

withstanding satisfactorily any overvoltage up to a maximum of 10% above the rated voltage, excluding transients.

(aa)Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute upon disconnection, in accordance with the provisions of the latest edition of IS:2834.

(bb)APFCR panel shall have suitable detuned reactors for harmonic filtration in case of PMCC connected with VFD or Soft Starters.

(cc)ThePFCsystemshall beprovided toachieveapowerfactorofnotlessthan0.98. (dd)Unit Protection

Each capacitor unit shall be individually protected by an HRC fuse suitably rated for load current and interrupting capacity, so that a faulty capacitor unit shall be disconnected by thefusewithout causingthe bankto be disconnected.Thus, the fuseshall disconnect onlythefaulty unit and shall leave the rest of the units undisturbed. An operated fuse shall give visual indication so that it may be detected during periodic inspection. The fuse braking time shall co- ordinate with the pressure built up within the unit to avoid explosion. Mounting of theindividual fuse may be internal or external to the capacitor case.

The Inputs to the APFC system is Voltage input from two phases and current input from the third phase. Out of two phases of voltage one phase voltage is taken as Reference 0 and another phase voltage as 440V. APFC need to be installed CT (Current Transformer) on the third phase at main incomer ACBaftertransformer, which shall give signal tothe APFCRelay. Basedon theseinputsthe ASIC (Application Specific Integrated Circuit) OR call it as Microprocessor internal to the APFC Relay shall give output signal to relay outputs which shall energize coil of the contactor so that the contactorcomeinlineconnectingthecapacitorbankincircuit.However,thisisstepcorrectionmeans PF shall be corrected in steps. The Voltage rise due to connection of capacitor banks is marginal.
ThereshallbenofrequencycorrectionwithAPFCSystemandAPFCRelayshallhavecommunication port (RS 485).

PowerCapacitorandControlPanel

(c) Power capacitor and control panel shall be housed in metal enclosed cubicle. Power capacitor shall be housed in the lower compartment and capacitor control panel at top compartment.

(d) The control equipment including capacitors shall be mounted in a panel of cold rolled sheet steel. The panel shall be of indoor type and shall consist of:

- Busbars shall be of copper conductor of hard drawn (HD) and high conductivity. All bus shallbe insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi.
- Isolatingswitch.
- Contactorwithoverloadelement.
- APFC Relays responsive to current / voltage / kVAR / PF as specified for

automatic switching shall be of microprocessor based suitable for both for state board Electricity and DG set with reduced power factor.

- Sequencing devices, timers and auxiliary relays for automatic sequential switching of the capacitors in and out of the circuit.
- Auto-manualselectorswitches.

- Pushbuttonforopeningandclosingthepower circuit.
- RedandgreenclusterLEDlightsforcapacitorsON/OFFindication.
- Protective numerical relays to protect the healthy capacitor units when one unit fails in a series connection.
- Spaceheaterandcubiclelightingasperthe requirements.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

SoftStarters

ApplicableStandards

Thedesign,manufactureandperformanceofequipmentshallconformtothelateststandardsspecified below.

SwitchgearGeneralRequirements	IS:13947/BS:5486/ IEC:60947
Factory Built Assemblies of SWGR and ControlgearforVoltagesuptoandincluding 1000V AC & 1200V DC	IS:8623/BS:5486/ IEC:60439
AirBreakSwitches	IS:13947-P3/BSEN60947/ IEC:60947-3
MouldedCaseCircuit Breaker	IS2516/IEC60947-2/BSEN60947-2
MiniatureCircuitBreakers	IS:8828/ BSEN:60898
Lowvoltage Fuses	IS:13703/BS:1362/IEC:60269-1
Contactors	IS:13947/BSEN60947-4/IEC:60947-1
Starters	IS:13947/BSEN60947-4/ IEC:60292-1to 4
ControlSwitches/Pushbuttons	IS:6875/ BSEN60947
CurrentTransformers	IS:2705/ BS:7626
VoltageTransformers	IS:3156/BS:7625/IEC:60044, 60186
Indicatinginstruments	IS:1248/BS:89/ IEC:60051
MarkingandIdentificationofConductors and Apparatus Terminals	IS:11353/ BS:159
A.C.ElectricityMeters	IS:722,8530/BS:5685/ IEC60145,60211

Degreeof Protection	IS:13947/IEC:60947-P1
Selectioninstallationandmaintenanceof switchgear and control gear	IS:10118
Codeofpracticeforphosphatingcoatediron and steel	IS:6005/ BS:3189
Specificationforcopperrodsandbarsfor electrical purposes	IS:613
Control transformers for switchgear and controlgearvoltagenotexceeding1000V AC	IS:12021
Classification of Hazardous areas having FlammablegasesandvapoursforElectrical Installation	IS:5572
GuideforSelectionofElectricalEquipment for Hazardous areas	IS:5571
Electricalapparatusforexplosivegas atmospheres-General Requirements	IEC:60079

ConstructionalandPerformanceFeatures

(r) The Soft start panel shall be indoor, metal clad, floor standing, compartmentalised completewith reactors, busbars, vacuum contactor, control, metering, protection equipment andindicating lamps, etc.

(s) Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidecovers.

(t) The Soft starter shall achieve smooth starting by torque control for gradual acceleration of the drive system thus preventing jerks and extending the life of equipment.

(u) Protectionshallbeprovidedforsoftstarters(semiconductorfuse).

(v) Startingcurrentshallbelimitedto3.0timesthefullloadcurrentofthemotor.

(w) TheSoftstartershallhavepossibilityforlowspeedforwardandbackwardoperationfor positioning of a motor.

(x) TheSoftstartershallhavebuilt-indiagnostics,faultdetectionandfault history.

(y) The Soft starter shall integrate motor and load protections, which shall under no circumstances be disabled when the integrated bypass shall be used.Thefollowing motor protections available along with warning function:

xiii) Electronicoverloadprotection.

xiv) Lockedrotor protection.

xv) Motorunderloadprotection.

xvi) Currentimbalanceprotection.

xvii) Voltageimbalanceprotection.

xviii) Overvoltage&undervoltageprotection.

xix) Phasereversal protection.

xx) Totalharmonicdistortion(THD).

xxi) Fans fault.
xxii) Thyristoroverload.
xxiii) Numberof starts.
xxiv) Motorruntimelimit.

(z) TheSoftstartershallmakeitpossibletorunthemotorinaweakernetworkandhenceimproving the availability of the system / equipment with following types.

iv) Current.
v) Dualcurrentlimit.
vi) Currentramp.

(aa) Separateremovable glandplatesshall be providedforpower and controlcables.Thegland plate for the power cables shall be of non-magnetic material.

(bb) All sheet steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate coated and then painted with two coats of zinc rich primer plant. After application of the primer, two coats of finishing synthetic enamel paint oven baked / stoved, shall be applied.

(cc) Thecablealleyshallhouseallpowercableconnectionsalongwithassociatedcable terminations.

(dd) Each cubicle shall be fitted with a label in the front and rear of the cubicle, indicating the panel designation, rating and duty. Each relay, instrument, switch, fuse and other devices shall be provided with separate labels.

(ee) Caution name plate with inscription “Caution - Live Terminals” shall be provided at all points where the terminals are likely to remain live and isolation shall be possible only at remote end, e.g., incoming terminals of main disconnecting switch.

(ff) Starting of motor shall be from either Soft Starter panel located near to motor or shall be from MCC Panel or from PLC. Necessary wiring diagram shall be provided considering starting interlock, trip circuit, starting and running mode signal.

(gg) Thesoftstarterpanelshallhavesoftstartandsoftstopfacilityduringnormaloperation. Thyristorfusesshallhaveatripindicatortooperateasuitablemicroswitchwithleast1NO+1 NC potential free contacts for annunciation and / or tripping.

(hh) Thesoftstarter panel shallbe installedinAir Condition room, it shallnotclub with PCC/MCC panels.
The soft starter panel shall be provided with sufficient ventilation for each unit. Necessary exhaustfan,louverswithfiltersmustbeprovidedinthe cubicletoensureproperventilation

Main Busbars

(f) Busbars shall be supported on insulators capable of withstanding dynamic stresses due to short circuit.

(g) Busbars shall be of copper conductor of hand drawn (HD) and high conductivity. All busbars shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi.

(h) The temperature rise of bus bars shall be limited to 40 degree centigrade over 45-degree centigrade ambient temperature.

(i) All sheet steel work shall be phosphate coated in accordance with the following procedure andinaccordancewithIS:6005“CodeofPracticeforPhosphatecoatedIronandSteel”.Oil,grease, dirt and swarf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphate coated, thorough rinsing shall be clean water followed by final rinsing with dilute dichromate solution and even drying. The phosphate coating shall be followed by the application of twocoatsofreadymixedstovingtypezincchromate primer.Thefirst coat maybe“flashdried”while thesecondcoatshallbestoved.Afterapplicationofthetwocoatsofprimerfinishingsynthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests.

The final finished thickness of paint film on steel shall not be less than 80 microns and shall not be more than 120 microns. Finished painted surface of panels shall present an aesthetically pleasing appearancefreefromdentsand unevensurface.Asmallquantityoffinishingpaintshallbesupplied for minor touching up required at site after the installation of the panels.

Earthing

(c) An earthing bus shall be provided at the bottom and extended throughout the length of thepanel. It shall be bolted / welded to the framework.
(d) All non-current carrying metal work of the panel shall be effectively bonded to the earth bus. Hinged doors shall be earthed through flexible earthing braid.

PanelAccessoriesandWiring

(n) Panel shall be supplied completely wired internally up to equipment and terminal blocks and ready for the external cable connections at the terminal blocks. Inter panel wiring between compartment of the same panel shall be provided.
(o) All auxiliary wiring shall be carried out with 1100 volts grade, single core, stranded copper conductor with PVC insulation. The sizes of wire shall be not less than 1.5sq.mm.
(p) Terminal blocks shall be of stud type, 1100 volts grade 10 amps rated, complete with insulated barriers. Terminal blocks for CTs shall be provided with test links and isolating facilities.
(q) All spare contacts and terminals of cubicle mounted equipment and devices shall be wired to terminal blocks.
(r) Accuracy class for indicating instruments (MFM with communication port-RS485) shall be 1.0. Instruments shall be 110 / 96 mm square, 240˚ scale for flush mounting with only flanges projecting.
(s) Relaysshallbesuitableforflushmountingwithonlyflanges projecting.

(t) Pushbuttonsshallbeprovidedwithinscriptionplatesengravedwiththeirfunctions.
(u) IndicatinglampsshallbeofLEDtype.
(v) Space heaters of adequate capacity shall be provided inside each panel. They shall be suitable for 240V, single phase, 50Hz supply. They shall be complete with MCBs, isolating switchesand thermostat.

(w) Each panel shall be provided with 240 Volts, 1 phase, 50Hz, 5amps, 3pin receptacles with switch located in a convenient position. An interior illuminating CFL / LED lamp together with the operating door switch and protective fuses shall be provided.
(x) Provision shall be made for receiving, distribution, isolating and fusing of auxiliary supplies for controls, space heating etc. The fuse ratings shall be so chosen as to ensure selective clearanceof sub-circuit faults.
(y) FusesshallbeHRCcartridgetype mountedonplugintypefuse base.
(z) The auxiliary supply shall be distributed inside the panel with necessary isolating arrangements at the point of entry and with sub-circuit fuses as required.

CableTermination

(d) Necessary number of cable glands shall be supplied for terminating auxiliary power and control cables. Glands shall be of heavy-duty brass castings, machine finished and complete with check nut, washers, neoprene compression ring etc.
(e) Cable lugs for all power and control cable connections shall be supplied. The lugs shall betinned copper / aluminium depending on cable conductor and of solderless crimping type.
(f) All necessary materials required for terminating the power cables such as tapes, fillers, binding wires, armour clamps, brass glands etc. shall be supplied.

DrawingsandData

AllDrawings,data,technical,particulars,temperaturerisecalculations,detailedliterature,catalogues, test certificates etc., shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

DieselStandby Generator

ApplicableStandards

TheDieselStandbyGenerator(asperlatestCPCBIV/ KSPCBnorms)anditscomponentsshall conform to the latest applicablestandards specified below:

DieselEnginesforGeneralPurposes	:	BS5514/ISO3046
TheElectricalPerformanceofRotatingElectrical Machinery	:	BS5000
RotatingElectricalMachines	:	IS15999-1
Circuitbreakers	:	IS-13118,BS-5311,IEC-56& 694, BSEN-60942

		(P-2)
Airbreakswitches	:	IS/IEC60947-3,IEC60947-3

Currenttransformer	:	IS 16227 (Part 2) : 2016/IEC 61869-2:2012/BS-7626,IEC-60185
Potential(Voltage)transformer	:	IEC60189
ElectricalRelays	:	IS/IEC-60255,IEC-60255
Contactors/Starters	:	IS/IEC60947-4,IEC60947-4
ControlSwitches/PushButtons	:	IS/IEC60947-5-1,IEC60947-5-1
HighVoltage Fuse	:	IS9385(Part1):2018 IEC60282-1:2009
LowVoltageFuse	:	IS/IEC60269-1:2014
IndicatingInstruments	:	IS-1248/IEC-60051
A.C.electricitymeters	:	IS11448/IEC62053
Resistancewire,tapesandstripesforheatingelements	:	IS-3725
Wroughtaluminumandaluminumalloybars,rods,tubes and sections for electrical purposes	:	IS-5082/IEC60114
Specificationforcopperrodsandbarsforelectrical purposes	:	IS-613
Toggleswitches	:	IS-3452/BS-3676
Controlswitches/pushbuttons	:	IS13947:Part5:Sec1/BSEN 60947
NoiseandEmissionLimit	:	As per latest notification of ministryofEnvironmenta nd Forests

GeneralRequirements

Thediesel engineand generator shall beskid mountedand shall belocated ina roomnear treatment plant substation building. The diesel engine shall draw cooling air directly from outside the room throughaweatherproof,acousticallytreatedduct.Theexhaust systemshallbeinsulatedtominimize the amount of heat entering the room and to prevent injury to personnel.

The exhaust system pipe shall be required height above the nearest building as per latest CPCB guideline. The exhaust pipeline diameter shall be suitably designed to avoid back pressure when dischargedathigherelevation.Thesilencershallbeofthe‘residential’typeandbelocatedexternally.

The generation voltage shall be 415V for D.G capacity less than 2 MVA and 11kV for D.G capacity morethan2MVA.IfmorethanoneD.Gsetshallberequiredforachievingtherequiredloadcapacity, they shall be operated in parallel with necessary synchronizing arrangement with LCD. At no point D.Gsetsshallbeoperatingparallelwith grid.

Tank

The tank shall be provided with fittings to permit the visual observation of fuel level and to enable filling by local tanker operators. A level sensor / switches shall also be mounted in the tank so that remainingfuelvolumecanbemonitoredatthegenerator/substationPLCandtheoperatorstationsin the SCADA room.

Fuelsystem

The fuel System shall comprise an engine driven feed pump with duplex filters, high level 990 litres day tank located in the generator room or generator skid mounted day fuel tank with supporting structureor generator skidmounted dayfuel tank, with all interconnectingpipe work, flexible engine connectionpipeetc.Asemi-rotaryhandpumpshallbeprovidedtopermittransferoffuelintheevent of a failure of the transfer pump. Any leakage from the pumps shall be routed to the bund.

Afirealarmsystemshallbeprovidedwithinthegeneratorroomtodetectfire,toraisealocal audible alarm (manually silenced locally).

AllalarmsshallbeconveyedtothecentralSCADAthroughthePLC.

DieselGeneratingSetAutomaticControl

AMFDieselGeneratorSetcapableofautomaticstartingandpickingtheloadwithin30secondsshall be provided to cater for emergency loads, lighting loads and other identified critical loads during mains power failure. Diesel generating set for use in auto mains failure mode shall have a three- position automatic / off / manual selection and shall operate as follows:

(iii) <u>Automaticmode:</u>
Onoccurrenceofmainsfailure,thefollowingsequenceshallbefollowed.

(c) MainstoGeneratorchangeover.
- mainsfailuredetected.
- delayof10 seconds.
- generatorshallbestartedandrunuptospeed.
- timedelayof50seconds.
- mainssupplyshallbeswitchedoff.
- generatorsupplyshallbeswitchedon.

(d)GeneratortoMainschangeover.

- mainsrestoredandhealthydetected.
- manualchangeoversignalreceived.
- generatorsupplyshallbeswitchedoff.

- mainssupplyshallbeswitchedon.
- generatorrunsfor2minutesand stops.

Alltimersettingsshallbeadjustable.

If mainspowershallberestored duringtheinitialone-minutedelaythenthepowershallbemonitored for a further one minute and if it shall be still healthy, mains power shall be restored. The generator shall be stopped after a further 2 minutes of running on no load. If the generator fails to start after an initial period of cranking, two further attempts shall be made with an appropriate interval between eachattempt.Iftheenginefailstostartafterthreeattemptsthesystemshallshutdownandalocaland remote alarm shall be annunciated.

(iv) Manualmode:
Thegeneratorshallruntothedictatesofmanualcontrolsonthegenerator.Noautomaticchangeover of mains to generator supply or vice versa shall take place. The generator shall be loaded by manual switching if required.

AlternatorforDieselGeneratingSet

Thegenerationvoltageshallbe415Vforcapacitylessthan2MVAand11kVforcapacity 2MVAand above.

Alternatorshall be4pole,3phase,50Hz,0.8P.F,salient pole,revolvingfield,Brushlesstype,self- regulating continuously rated and manufactured in accordance with IS 15999-1, BS 5000: Part 99 or IEC 60034-1. They shall be totally enclosed, screen protected, fan ventilated and vertical drip-proof conforming to IP 23.

The Alternator shall be complete with excitation system, AVR and all necessary auxiliaries. The alternator shall bedriven bydieselengine detailed belowand shall match the same in all respects.The terminal box shall be dustproof with IP 54 degree of protection. The terminal box shall be suitably sizedtoterminatethesizeandnumberofcablesinvolved.Alternatorsshallbecapableof withstanding a 10% overload for 1 hour in any 12 hours Period under the specified conditions of temperature, humidity and atmospheric pressure.

Alternator windings shall be of Class H insulation with Class F temperature rise and tropicalised. The alternator shall have pre-packed grease lubricated ball or roller bearings and provided with facilities fordegreasingwhilstinservice.Thealternatorshallbefootmountedon acommonbedframewiththe prime mover close coupled to the engine flywheel housing. The direction of alternator rotation when viewed from the driven end shall be clockwise and phase voltage sequence UVW. The alternator vibration level shall not exceed the values defined in IS 12075/ IEC 60034-14. The alternator shall be capable of maintaining a short circuit current of three times full load current for a period of 10seconds.

The alternator shall be fitted with an anti-condensation Alternator shall have 6 nos. duplex RTDs insidethestatorwinding.Noindividualharmonicshallexceed1%andthetotalharmonicshallnot

exceed3%.Thealternator,it’sneutralandcontrolpanelshallbeearthedasperrelevant standards. Alternator rotor assembly shall comprise exciter rotor, full wave silicon bridge rectifier, surge protection device and salient pole rotating field system.

Therotorshallbefittedwithinterconnectedpolefacedampingwindings.Voltageregulationshallbe maintained to within ± 2.5% for a power factor of 0.8 to unity, including hot to cold variations. The steady state frequency droop between no load and full load shall not exceed 5%. Transient voltage deviation following a step load of 60% of rated at a power factor of between 0.4 and zero shall not exceed 15% with a voltage recovery time to 97% rated voltage not exceeding 0.5second.

The set shall be capable of continuous operation with a phase current imbalance of 33% of rated current whilst maintaining the output voltage within ± 5% of rated. Alternator shall have sensors for alternatorprotectionandshallbewiredtocontrolpanel.Thealternatorshallbeprovidedwithclass F insulation with temperature rise limited to that of class B insulation.

DieselEngineforGeneratingSet

Engineshallbefour-stroke,directinjection,andturbochargedindustrialmachines.Theyshallbefitted with renewable wet cylinder liners if water cooled and shall be direct coupled to the alternator and mounted on a common rigid steel bedplate. Engines shall be rated for continuous duty at site ambient conditions with an inherent O/L Capacity of 10% for 1 hour in any 12 hours. The engine shall be capable of running at full load for not less than 180 hours without maintenance adjustments and10,000 hours between major overhauls. The maximum operating speed shall be 1500 rpm. The range of manual adjustment shall not be less than ±5% of rated speed.The performance of engine governors under load conditions shall be to Class A2 in accordance with BS 5514: Part 4.

Enginegovernorsshallbesuitableforremotecontrolloadsharingbetweenidenticalengineunits.In addition toanyelectricalover speedtrips,thereshall bea mechanical overspeed device which shall operate at 120% of the rated speed. Re-setting of the over speed trip shall be possible by hand only. Thesteadystateoutputspeed drop between no load and fullloadshall not exceed5%.Thetransient output speed deviation shall not exceed 10% for a step of 60%.

Engines shall be designed to run on fuel oil complying with IS 1460 or BS 2869, Class A2. Engines shall be cooled by means of a water jacket, heavy duty air blast radiator with integral radiator header tank,circulatingpumpandenginedrivenpushertypefan.Thefanshall drawairinfromthevicinityof the engine block and discharge it through the radiator core. The radiator shall be mounted on the same bedplate as the engine and alternator on suitable vibration isolators and be arranged so that it shall be located directly behind automatic louvers set into the external wall of the engine room. A thermostatically operated by-pass valve shall be fitted in the cooling system to maintain an optimum operating temperature during starting and

running conditions. Drain cocks shall be provided so that all the water can be drained from the system. A separate oil cooler shall be used for cooling the engineoil. A thermostatic by-pass valve shall be incorporated.

Engine lubrication shall be by a closed-circuit wet sump, forced feed system supplied by an engine driven pump fitted with pressure regulating and relief valves, sump suction filter and changeover renewablemicro-feltfullflowlinefilters.Ahandoperatedsemi-rotaryoilpumpshallbeinstalledto

carry out initial priming or to fill or empty the sump as required. The sump shall be fitted with an easilyaccessibledrainpoint.Theoilshallbeofthegraderecommendedbytheenginemanufacturer.

The starting system shall comprise 12 or 24V heavy duty lead acid batteries (positioned on a floor mountedstandadjacenttotheengine)connectedbyheavydutyflexiblebutylrubbercables.Batteries shall be sized to give six consecutive starts of the engine at 0˚C. An engine driven alternator and charging system shall be provided. An automatic main energized battery charger shall be provided, with sufficient capacity to maintain the battery in a condition to full fill the starting requirements.

Barring(handturning)equipmentshallbeprovidedsothattheenginecanbemanually rotatedfor maintenance purposes. It shall be arranged sothat normal startingof the engine shall be inhibited whilst the hand turning equipment shall be connected.

Twinheavy-dutyairintakefiltersinaccordancewithIS3169orBS7226suitableforoperatingindustladenatmospheresshallbefitted.Thefiltersshallbeofthepaperelement withpre-cleaner type.Turbo charger filters shall be fitted. Breathers shall be fitted with washable filters which are easily accessible for maintenance.

Instrumentation shall be provided to monitor speed, oil pressure, oil temperature (sets larger than 250kVA), water temperature and battery charge current. The bedplate shall be of heavy gauge steel construction,stressrelievedandfreefromdistortion.Engineshallbeprovidedwithsensorsforengine protection and shall be wired to control panel.

Machinedsurfacesshallbeincorporatedformountingsandforlevelling.Anti-vibrationmountings shall be fitted between the bedplate and the floor to prevent vibrations being transmitted to the building. The mountings shall be adjustable for levelling purpose and shall be designed to resist horizontal movement of the diesel set.

The fuel system shall comprise an engine driven feed pump with duplex filters, 990 litres day tank withsupportingstructuresorgeneratorskidmounteddayfueltankwithallinterconnectingpipework, flexible engine connection pipe etc.

DieselGeneratorControlPanel:

The control panel shall haveprovisionsuchthatinter-operabilitywithinstrumentationcontrol system. The control panel with communication facility shall be separately mounted on anti-vibration mountings and shall comprise the following:

- Breakerincorporatingshortcircuitandoverloadtrip.
- Earthfaultprotectionforthe Alternator.

- AlternatorOver&UnderVoltageProtection.
- VoltageControlledOverCurrentRelay.
- Voltmeterwithbuiltinselectorswitch/(digital)
- ammeterwithbuiltinselectorswitch/(digital)
- frequencymeter
- PowerFactorMeter
- KWhMeter(Multifunctionmeter)

- Enginetemperatureandoilpressuregauge
- servicehoursrun indicator
- keyswitchstartsandstop control
- operationalstatusindicator
- anti-condensationheaterandthermostat
- alternatoranti-condensationheatercontrols
- mainsfedbatterycharger
- Autostartonmainspowersupplyfailurefacility
- FailstoStart(Alarm)
- Over/UnderVoltage(Alarm)
- BatteryChargerFault (Alarm)
- LowfuelOilLevel (Alarm)
- Overload(Alarm)
- LowLubeOilPressure(Trip)
- HighWaterTemperature(Trip)
- HighLubeOilTemperature(Trip)
- ElectricalProtectionRelays(Trip).

Aresetbuttonshallbeprovidedtocancelthealarm/shut-downconditionpriortore-starting.

Simple operating instructions shall be detailed on the fascia of the control panel. All alarm and trip statussignalsfromdieselsupplysystem,enginecontrolpanelandalternatorprotectionshallbehard wired to a marshalling box for instrumentation control system.

Busbars shall be of copperconductorof hand drawn(HD) and high conductivity. All bus bars shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of highdielectricstrength,toprovideapermanentnon-ageingandnon-trackingprotection,imperviousto water, tropical conditions and fungi.

SynchronisingPanel

Whenevertwoormore setsarerequiredtooperatetogether,necessarysynchronizingpanelcomplete with circuit breaker, synchro scope, numeric relays, digital meters etc shall be provided. The Panel shall be floor standing, CRCA Sheet steel enclosed.

AcousticEnclosure

(vi) TheDGSetshallbeprovidedwithacousticenclosure,fullyintegrated,weatherproofwith superior finish for long and durable life.

(vii) TheacousticenclosureshallbeCRCAsheetsteelenclosedwithnecessarypanelsanddoors, inside lining of fire-retardant foam / glass wool as acoustic material.

(viii) Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidecovers.

(ix) The sound level shall be restricted to 75dB at a distance of 1 meter, under

full load, free fieldconditions as per relevant standards.

(x) Theacousticenclosureshallbecertifiedtomeettheemissionnorms.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

UPS,Battery,Battery ChargerandD.CDistributionBoard

UPSshallbesuppliedasperInstrumentationspecification.UPS,Battery,BatteryChargershallbe three phase incomingsupplywith breaker. DC equipment shall complywith IEC 60896 including those standards referred to therein.

GeneralRequirements

Followingitemsshallbecoveredinthe Contract:

- One no. 110V Nickel Cadmiumtype Battery Bank (sized as per requirements mentioned in Part 12).
- Oneno.Float-cum-boostchargerfor110Vbatteries.
- DCdistributionboard.

Allconnectionsbetweenbattery,batterychargersandDCdistributionboard shallbedesignedfor effective segregation between positive and negative leads.

BatteryRoomLayout Requirements:

- Batterycellsshallbeinstalledinseparateroompreferablyneartheloads.
- Light fixtures in the battery roomshall be flameproof and shall preferably mounted on walls, or if installed on ceiling shall not mounted directly above the battery banks. Switch controls for lights and exhaust fans shall be installed outside the battery room.
- False ceiling & false flooring shall be avoided in the battery room. Ducts or other systems shall not be run through battery room.
- 2 Nos.flameproofexhaust fansshall beprovidedtoexhaust gasesandsmoke frombatteryroom (in case of fire from battery room).
- Battery room upto 2 mtrs height shall be provided with acid proof tiles. Wall above 2 mtrs and roof beams shall be painted with Alkali resistant protective coating.
- Washbasinwitheyewashershowershallbeprovidedinbatteryroom.
- A warning sign board should be displayed at the entrance and inside to the battery rooms inview of presence of Hydrogen gas. Hydrogen gas detector shall be installed based on vendor recommendations.

Nickel-CadmiumBattery

DesignFeatures

(k) Battery offered shall be Nickel Cadmium (Ni-Cd), Sintered Type. The battery shall conform to the latest applicable standards specified below:

Specificationforsinteredtype : IS 10918

NickelCadmiumSinteredBatteries

(l) Nickel hydroxide and Cadmium hydroxide shall be used for positive and negative electrode respectively. Aqueous solution of battery grade Potassium hydroxide with small quantities of lithiumhydroxide shall be used as electrolyte. It shall be used only for ion transfer and shall not chemically change during charging / discharging.

(m) The containers shall be transparent and preferably be made of toughened glass or plastic polypropylene material and provided with electrolyte level indicator. The Containers shall be robust, heat resistant, leak proof, non-absorbent and free from crack, blisters, pin hole etc.

(n) Thebatteryshall beratedon5-hourbasisandforthespecifiedambienttemperature.Thebattery shall have maximum recharge time of 8 hours.

(o) Terminal posts shall be designed to accommodate external bolted connection conveniently and positively. Eachterminal post shall have two bolt holes of the same diameter, preferablyatright angles to each other. The bottom hole shall be used to terminate the inter-cell connection. The top hole shall be left for external terminal connections. Bolts, heads and nuts, except seal nuts, shall be hexagonal and shall be lead covered. The junction between terminal posts and coverand between cover and container shall be so sealed as to prevent any seepage of electrolyte.

(p) Required quantity of electrolyte for first filling with 10% extra shall be supplied in non- returnable containers.

(q) Each battery shall be complete with following accessories, as applicable, that include, but are not limited to:

(v) Batteryracks.

(vi) Porcelaininsulators,rubberpads,etc.

(vii) Setofinter-cell,inter-tierandinter-banknickelcoatedcopperconnectorsas required for the complete installation.

(viii) Electrolyteforfirstfilling+10%extra.

1setofaccessoriesfortestingandmaintenanceshall

alsobeprovidedsuitableforallthethreebattery banks.

i.	One	-	-3,0,+3voltsDCvoltmeterwithbuilt-indischarging resistorand suitable leads for measuringcell voltage.
ii.	One	-	Fillerholefloatfittedwithplugandcapandhaving specific gravity correction scale.
iii.	Three	-	DigitalportablePocketthermometers.
iv	Two	-	Cellliftingstraps.
v	Onesetof Each	-	Terminalsandcableboxeswithglandsforconnecting cable as required. Spare connectors. Spare vent plugs. Sparenutsandbolts. Suitablesetof spanners.

(r) Each battery shall be mounted in a manner that permits easy accessibility to any cell. The racks shall be suitable for fixing on flat concrete floor. The complete racks shall be suitable for bolting end to end.

(s) It shall be the responsibility of the contractor to provide batteries of adequate capacities to meet specified requirements pertaining to control, indication, annunciation, etc. and emergency lighting. For computing battery capacity, it shall be assumed that the battery is fully charged at the beginning of loading cycle and is discharged to a voltage of 1.2 volts per cell at the end of the loading cycle. The battery shall have minimal difference (approx. 0.3 V per cell) between float and boost charging voltages.

(t) Thefollowinginformationshallbelegiblymarkedonoutsideeachcell.

- Manufacturer’sName&Trademark.
- Country&YearofManufacture.
- AHCapacityat5-hourdischarge rate.
- TypeDesignation&Sl.No.

Drawing

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc shall be

submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

BatteryChargerandD.C.DistributionBoard

ApplicableStandards

The battery charger and D.C. distribution board shall conform to the latest applicable standards specifiedbelow.IncaseofconflictbetweenthestandardsandthisSpecification,thisSpecification shall govern.

Basic climatic and mechanical durability : IS/IEC60068 tests for components for electronic and

electricalequipment		
Environmental tests for electronic and	:	IS/IEC60068
Electrical equipment		
Metal clad base material for printed	:	IS:5921
circuits for use in electronic and telecommunicationequipment		
Transformers and inductors (power,	:	IS:6297
audio, pulse and switching) for electronicequipment		
Printedwiringboards	:	IS:7405
Environmental requirements for semi-	:	IS6553
Conductor devices and integrated circuits		
Terminals for electronic equipment	:	IS:4007
Factory built assemblies of switchgear and controlgearforvoltagesuptoand		
including 1000V AC and 1200V DC IEC:60439	:	IS:8623/BS:5486/
Airbreakswitches BSEN60947-3	:	IS:13947(Part - 3)
Miniaturecircuitbreakers BSEN:60898	:	IS8828/
HRCcartridge fuses	:	IS:9224/BS:88
Contactors BS:775 / IEC:60158-1	:	IS:13947(Part-3)/
Controlswitches/pushbuttons	:	IS:6875

Indicatinginstruments	:	IS:1248/BC:89/ EC:51
Degreeof Protection	:	IS:13947-(Part1)/ IEC:60947-1

Climate-proofingofelectricalequipment	:	BSCP:1014
Code of practice for phosphate coated iron and Steel	:	IS:6005/BS:3189
Semi-conductorconverters	:	IEC:60146
Semi-conductor rectifier equipment safety code	:	IS:6619
Specification for copper rods and bars for electrical purposes	:	IS:613

Batterycharger

(l) Batterychargershallbecombinedfloat-cum-boosttype.

(m) The charger shall be static type composed of silicon-controlled rectifiers (SCRs) and diodes connected in three phase full wave half-controlled bridge circuit.

(n) The rectifier transformers for float and boost chargers shall be indoor dry type, double wound with delta-star connections. The BIDDER shall ascertain if taps are required and provide adequate number of primary and secondary taps, if necessary.

(o) Thefloatchargershallbedesignedforsupplying:

(iii) TheD.Ccontinuousloadandshort-time overload.

(iv) Thetricklechargingcurrentofthebattery.

(p) Theboostchargershallbedesignedforsupplyingtheboostchargingcurrentofthe battery.

(q) If the battery and charger are to be supplied by separate contractors, the charger contractor shall coordinate with the batterycontractor regarding float / trickle boost charging current & voltages required for the battery.

(r) Battery Charger shall be provided with facility for both automatic and manual control of output voltage and current and necessary selector switch shall be provided. contractor regarding the float / trickle and boost charging current and voltages required by the battery.

(s) Performance

(iv) FloatCharger

TheD.C.outputvoltageduringfloatchargingshallbestabilizedwithin ±1%ofthesetDCbus voltage. Manual control shall be used if auto mode fails.

(v) Boost Charger

Forboostchargingthedischargedbatteryafteramainsfailure,therectifiershallcharg ethebatteryat high rate limited to the maximum boost charging voltage.

After a specified number of hours (adjustable) when the rated cell voltage shall be reached, the charger shall be returned to float charge status.

- In case of combined float cum boost charger, the switching and control of high-rate charge and returntofloat chargeshallbebyautomaticcontroller/regulator.Manual controlshall beusedif auto-mode fails.
- Duringboostchargingfollowingemergencymeasuresshallbeprovided:

- If the AC mains supply fails, an arrangement shall be made to automatically connect the battery directly across the load.
- IftheseparateorsparefloatchargersupplyingD.C.loadfails,theloadshallbefedfr om the point of connection at the tapping of the battery via adequately rated blocking diodes.

(vi) Suitablefilter Circuitsshallbeprovidedinthechargers tolimittheripplecontent(peakto peak) in the output voltage to 1% irrespective of D.C Loads.

(t) TheD.CSystemshallbeunearthed.sensitiveearthfaultdetectorsshallbeprovide dinD.C system to annunciate earth fault.

(u) Specialdigitalammeterwithzerocentreforstatusofbatterychargingand discharging.

(v) Allothermetersshallbedigitaltypeonly.

ChargerPanelandD.C.DistributionBoard

(l) Battery charger panel and D.C. distribution board shall be sheet metal enclosure free standing type with cable entry from bottom.

(m) Indications, controls and output voltage setting adjustments shall be on front panel. The contractor shall submit a scheme for alarmand trip indication lamps on the cabinet and for fault annunciation contacts paralleled for remote annunciation.

(n) The components shall be liberally rated and housed in a well-ventilated sheet metal cubicle complete with input and output terminals. Louvers shall be provided for ventilation backed up by fine wire mesh so that the degree of protection shall be equal to or better than IP-42.

(j) Busbars shall be of Electrolytic copper Grade conductor of hard drawn (HD) and high conductivity. All busbars shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non- ageing and non-tracking protection, impervious to water, tropical conditions and fungi.

(o) All printed circuit cards shall be plug-in type, interlocked to prevent insertion in a wrong slot. Each card shall have LED indication on its front plate to indicate normal condition and readily and marked test pins.

(p) Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidecovers.

(q) All components shall be accessible to the maintenance technician for easy disassembly and replacement. Access to parts of equipment shall be with minimum danger from all hazards.

(r) All components and modules shall be clearly and unambiguously marked and all wiring colour- coded and tagged.

(s) All power and control wiring within the cubicle shall be done with stranded copper wires. The power wiring shall be adequately sized for the required rating. The minimum sizes for control wiring shall be 1.5 sq.mm and for power wiring shall be 2.5 sq.mm650 / 110V grade.

(t) Groundterminalswithisolatinglinksshallbe provided.

(u) Cableglandsshallbeprovidedtosuittheincomingandoutgoingcables.

(v) DCDBshallmeettheemergencylightingrequirementalso.

Components/ Accessories

(xxii) The main items are listed below. However, additional items required for completeness or tomeet the specified performance or operational requirements of the charger, shall be deemed tobe included in the contractor’s scope. Instead of incoming ON / OFF switches, sticker fuses and

contactors, the contractor may provide suitably rated 3 pole MCBs with overload and short circuit protection and auxiliary contacts.

(xxiii) One (1) set - Three phase full wave half-controlled bridge rectifier circuit comprising silicon- controlled rectifiers and silicon diodes complete with resistor / capacitor network for surge protection. The diodes / SCRs shall be individually protected by fuses with fuse fail indication.

(xxiv) One(1)Doublewound,drytype,threephasessuitablyratedmainstransformer.

(xxv) One(1)setofsuitablyratedcontroltransformersforelectroniccontroller.

(xxvi) One (1) Electronic controller comprisingof power supplycard, soft start cumcurrent limit card, auto trickle mode card with facility for setting trickle charge current and monitoring battery current, error amplifier cards and pulse generating cards for achieving the DC output voltage stabilisation of ± 1% and also for achieving current limiting feature. The electronic controller shall have protection features with indications for under-voltage, over-voltage, set outputvoltage and phase failure or voltage unbalance.

Theelectroniccontrollershallbeprovidedwithfollowingfeatures.

- Boost current stabilization of ± 2% with AC input variation of voltage and frequency variation of ± 10% and ± 5% respectively.
- Boostchargecurrentlimiterwithpotentiometertoadjustthesetting.

(xxvii) Adequately sized necessary built-in accessories shall be provided such that on failure of the controller in auto mode the voltage can be effectively controlled manually.

(xxviii) One (1) Filter circuit comprising of smoothing choke and condensers complete withHRC fuse with trip indication for filter condenser circuit.

(xxix) One(1)Auto/Off/ Manualselectorswitchforselectingthemodeofoperationofthecontroller.

(xxx) One(1)frontpanelmountedpotentiometerforsetpointadjustmentofoutput voltageinauto mode.

(xxxi) One(1)frontpanelmountedpotentiometerformanualadjustmentofvoltageinmanualmode.

(xxxii) One(1)TPACON/OFFswitchforfloatchargerincoming.

(xxxiii) One(1)setofMCB/ HRCfusescompletewithfittingsforACinputwithsuitable ratings and trip indication.

(xxxiv) One (1) set of the pilot lamps with series resistors to indicate float charger AC Mains ‘ON’ condition.

(xxxv) One(1)Digitalvoltmeter,ammeterandfrequencymeterforMains.

(xxxvi) One(1)ACcontactorwithsuitablyratedcoilandthreemainand2NO+2NC auxiliary contacts, suitably rated thermal overload relay and ON / OFF control switch.

(xxxvii) One (1) set of HRC fuses complete with fuse fittings for the DC output, and with trip indication.

(xxxviii) One (1) moving coil DC ammeter, with shunt, of size 96 x 96 mm and suitable range to read the float charger output current.

(xxxix) One (1) moving coil DC ammeter, with shunt, of size 96 x 96 mm and suitable range to read the charging and discharging current for battery.

(xl) One(1)DoublepoleDCON/OFFMCBswitchforfloatchargeroutput.
(xli)One(1)pilotlampwithseriesresistortoindicatefloatchargerDC‘ON’condition. (xlii)Annunciation System with communication facility for the following

- ACSupplyFailure.
- RectifierFuseFailure.

- SurgeCircuitFuseFailure.
- FilterFuseFailure.
- LoadLimiterOperated.
- ChargerTrip.
- Batteryon Float.
- Batteryon Boost.

PowerElectronicComponents

(g) Diode and thyristors shall be of monocrystalline type silicon, capable of continuous output at specified voltages. It shall have high power efficiency.

(h) If manydiode orthyristor assemblies areconnected inparallel,careshall betakentoensurethat each rectifier or thyristor operates within its rating and shares the load uniformly. This may be achieved with the help of chokes. Also, care should be taken to select matched pairs of rectifier heat sink units.

(i) Each diode or thyristor built in a multi-built assembly shall be provided with a short circuit protection to avoid complete shut-down of the equipment because of a fault on single unit. Suitable fuses shall be provided for such protection.

(j) Necessary spare capacity shall be built in the equipment to continuously supply full load even with one unit out of circuit.

(k) Thediodesorthyristorbanksshallbenaturalair cooled.

(l) The diodes or thyristors shall be protected against over voltage due to chopping surges with the aid of snubbers (i.e., resistor-capacitor combination and Metal oxide varister). It shall beensured that normal load currents and especially fault currents are shared equally between parallel links, within the specified limits. To achieve this, great care shall be taken to design the layout of the rectifier links to ensure equal lengths of busbars and as near as possible identical contact resistance in each current path.

DrawingsandData

AllDrawings,data,technicalparticulars,temperaturerisecalculations,detailedliterature,catalogues, type test certificates of typical transformer etc shall be submitted along with the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

VariableFrequencyDrives

VariableFrequencysystemshallhaveprovisionsuchthatinter-operabilitywithinstrumentationcontrol system for flow control.

ApplicableStandards

(k) Specificationformetalclad base IS:5921
materialsforprintedcircuitsforuse

inelectronicandtelecommunicationequipment

(l) SpecificationofTransforme rsand IS:6297
Inductors(Power,Audio,PulseandSwitc

hing) for Electronic Equipment

(m) Semiconductorrectifierequ ipment IS:6619
safetycodefor

(n) Specificationforprintedw iring IS:7405
Board

(o) Recommendedpracticeforemergencyand
standby power systems for industrial
and commercial

application.
IEEE:446

(p) Semiconductordevices
IS:3700

(q) Basicclimatefor mechanical
IS:9000
durabilitytestsforelectronic

components

(r) Environmental requirements of semiconductor

IS:6553 devices and integrated circuits

(s) Ambienttemp.of electronic
IS:9676
Equipment

(t) Terminalforelectronicequi pment IS:4007

Configuration

Frequency drives shall have one of the two configurations given below Suitable for induction motor protectionofalltypesconfirmingto IS12615/IEC60034/IS13947(Part4/set1)1993/IEC 947-4-1(1990):

(c) Currentsourceinverter.
(d) Voltagesourceinverter.

Converter

TheConvertershallbeoffullwaverectifiertypewithminimumnumberofpulses6or more Smoothing Reactors for Current and Voltage Source Inverter.

(j) Thesmoothingreactorshallbesizedtoavoidconditionsofdiscontinuouscurrent
(k) Drives shallhave ultra-lowharmonic drive (ULH)to reduce harmonic reduction toless than 5% THD_i(total harmonic distortion-current and voltage). Modern, compact, all-in-one solution that ensures harmonics are mitigated at source at all loads when connected to either a mains or generator supply.
(l) Operation of the frequency converter at its lowest frequency of operation, which shall not beless than 5Hz.
(m) The smoothing reactor shall be uniformly insulated and shall be protected for voltage surges occurring during sudden load throw-off.
(n) The smoothing reactor shall be made from electrolytic grade copper and shall be epoxy encapsulated with suitable class of resin decided from techno-economic considerations and performance requirements in conformity with IEC-146.
(o) Drivesshallhavecoolingfansforadditionalenergysavingduringpartialloadsituations .
(p) Semiconductorfuseshallbeprovidedforprotectionofdrive.
(q) Drivesshallhavebuilt-inEMCfilterssuitablefornetworkconnectionasstandard.
(r) Drivesshallhavefollowingfeatures:
(xii) Level control.
(xiii) Pumpcleaning.
(xiv) Intelligentmulti-pumpcontrol.
(xv) Flow calculation.
(xvi) Pumpprotection.
(xvii) Quickramps.
(xviii) Turbidityreduction.
(xix) Communicationslossbackupmode.
(xx) EMCcompliance.
(xxi) Modbus protocol.
(xxii) Safetorqueoff.

Inverter

Theinvertersystemsuitableforthreephaseoutputshallconsistofthefollowingsubsystems:

ThebasicinvertercircuitconsistingoftheswitchingdevicesayThyristors/ Transistors/IGBT/ MOSFET, connected so as to supply three phase power.

(e) The logicnetwork toenablerapid transitionofthe maininverterswitching devices from on-state to off-state.

(f) Suitable feedback system to allow balance of reactive power flow during load power factor fluctuation as well as regeneration.

(g) The filter system of the inverter output to suppress 5th, 7th, 11th, 13th harmonics atthe output of the inverter to less than 5% of the fundamental amplitude.

(h) Theripplecontrolsystem tolimitcurrentrippleto4%attheinputterminalsofthe inverter caused by distorted current output.

Theoutputfrequencyofinvertershallbecontrolledtowithinthe limits.

InverterforACdrive

(iii) CurrentSourceInverter

(c) ConstantTorque Operation
Thecurrent output bythe DClinkshallbe accuratelymonitoredso thattheratioof the terminal voltage of the motor and the corresponding frequency remains constant. Necessary protective featuresfortrippingthefrequencyconverter,alarm/annunciationandfaultdiagnosticsshallbe provided.

(d) ConstantHorsepowerOperation
Inthistypeofoperation,themotor'sinternalvoltageshallbemaintainedwithin+1%whilethe frequency of the inverter shall be varied to meet the duty cycle requirements. Necessary protective features for tripping the frequency converter, alarm / annunciation and fault diagnostics shall be provided.

(iv) VoltagesourceInverter

(c) ConstantTorque Operation
The DC voltage input to the inverter shall be accurately monitored to maintain the ratio the terminal voltage of the motor to frequency at the rated / design value. The DC voltage input shallbemaintainedwithin+1%oftherequiredvalue.Shouldthisfallforanyreason,necessary action for tripping the frequency converter and initiation of annunciation / alarm and fault diagnostic shall be provided.

(d) ConstantHorsepowerOperation
Inthistypeofoperation,thevoltageattheterminalsofthemotorshallbemaintained within+ 1%oftheratedvaluewhilethefrequencyoftheinvertershallbevariedtomeetthedutycycle requirements. Necessary protective features for tripping the frequency converter, initiation of alarm / annunciation and fault diagnostic shall be provided.

OutputOvercurrent Limit

Unless otherwise stated, the inverter shall be capable of being temporarily

overloaded to 150% of its fullloadamperecapacityforsixty(60)secondsbeyondwhichacurrentlimitactionshall beinitiated, and an alarm contact initiated for annunciation.

ControlModules

All elements of the controlsystemshallbe mounted onepoxylaminate boardsandeach board shallbe a plug-in module mounted on a standard nineteen-inch rack which shall be accessible from the front. EachcardshallhaveLEDindicationonitsfrontplatetoindicatenormalconditionofthecard.Readily accessible and clearlymarked test pins shall be provided at the important points on the cards to enable signal analysis.

The epoxy laminates shall be free from manufacturing errors and shall be designed to prevent incorrectinsertioninthecardrack.Thecoppersideofthecardshallbesuitablylacquered toprevent oxidation. The gap between two cards shall be sufficient to permit adequate ventilation.

Adjustmentssusceptibletochangebyaccidentalcontactshallbelockable.

ControlRequirements

Shorttimevoltagedipsupto80%ofnominal(e.g.,incaseoflargemotorstart-upconnectedtosame bus) shall not cause the control system to stop functioning and shall not trip the drive system.

Thedrivemotorshallbespeedregulatedcorrespondingto4 -20mAor0 -10Vreferenceinputsignal. Uponcompletelossofusersspeedreferencesignal,thedriveshallautomaticallyrunatconstantspeed as determined by the last speed reference available prior to loss of the signal.

TherequiredprovisionforinterfacingwithPLC/ DCS,includingdetailsofcommunicationmodule and data transfer facility, I/O details shall be furnished by the Bidder.

Protection

ProtectionofPowerSemiconductor

Eachpowersemiconductorshallbeprotectedagainstshortcircuit.Thefuseshallbe sizedsothatitsI^2t does not exceed the I^2t characteristic of the power semiconductor itself.The voltage and current rating of the fuse shall match the duty on the power semiconductor. The arc voltage, due to melting of the fuse shall not exceed the repetitive peak reverse voltage of the power semiconductor.

Thyristorfusesshallhaveatripindicatortooperateasuitablemicroswitchwithatleast 1NO+1NC potential free contacts for annunciation and / or tripping.

Afast-trippingfeedercircuitbreakershallbeusedincasefusesforshortcircuitprotection of thyristors are not used.

ProtectiveSystemsforACInverterDrive

Fusesforallpowersemiconductorsand/ orotherdeviceslikecommutationchokes,capacitorsetc. which are not adequately protected against flow of abnormal currents.

Undervoltageandovervoltageprotectionontheinputside.Lossofinputvoltagetoinverters hall entail tripping of the inverter.

Protectionforallcontrolcards,powersupplystabilizers,filtercircuitsetc.Protecti onshallbe provided such that failure of a part does not cause damage elsewhere in the system.

- Polarizingrelaytopreventreversalofpolarityontheinputsideoftheinverter.
- Protectionofinverterthyristor,commutatingcircuitsandotherinverterelement sduring regenerative operation of the inverter and also during sudden load throw-off.
- Currentlimitfusesattheoutputoftheinverter.
- Commutationcircuitundervoltage.
- Inverteroverfrequency.
- Programmableovercurrent.
- Phasesequence/ lossofphaseprotection.
- Earthfaultprotection.
- DClinkovervoltageprotection.
- Specificmotorprotection.
- Incominglinesurgeprotection.
- VentilationLoss.
- Overtemperature.

CoolingofPower Converters

Powersemiconductorsshallbemountedonheatsinkwhichcanbeindividualorcommo ntoanumber of devices. Adequate provision for clamping and mounting the power semiconductors shall be available.

Cooling of power semiconductors can either be natural air cooled or forced air cooled. The BIDDER shallrecommendthetypeofcooling.However,forpowerconverterswhichexceedcapa citiesof2kA continuous load, alternative cooling methods as oil or water cooling shall be considered. The power semiconductors shall preferably be double side cooled.

SwitchingDevices

Switchingdevicessuchascircuitbreakers,isolators,contactors;switch-fuseunitsetcshallbe considered in the scope of supply.

Theswitchingdevicesshallbeenclosedinaseparateenclosureformingtheset ofpanelsforthepower converters. They shall have adequate clearance both with adjacent devices and metalwork at earth potential. Connection between devices shall be by adequate size of electrolytic grade of copper strips. These connections shall be adequately braced and insulated.

ConstructionalFeatures

Thecontrollershouldhavemodularconstructiontofacilitatemaintenance.

Thedriverating22kWandabovethereisaseparate(VFDpanel)panelshallbeprovided andinstalled in Air Condition room, it shall not club with PCC / MCC panels. For protection semiconductor fuse shall be provided for Variable Frequency Drives

(VFD).

Busbars

Power connections shall be of the bolted type and mating surfaces shall be tinned. The bus bars runningtovariousconvertersshallbesuitablydesigned toensureequalsharingbetweentheparallel strings and prevent mechanical stress on the fuse.

All bus bars shall be of Electrolytic copper Grade conductor of hard drawn (HD) and highconductivityAllbusbarsshallbeinsulatedwithclosefittingsleeve ofhard,smooth,dustanddirtfree, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-ageing and non- tracking protection, impervious to water, tropical conditions and fungi.

Allcubiclesshallhavecopperearthbusesofadequatesizerunningtheentirecubiclehei ghtalongthe sides.

Cubicle

Cubicleshousingthepowersemiconductorsanddrivelevelcontrolsystemshallconfo rmtoIP42 degree of protection to enclosures.

Panelsshallbefreestanding,floormountingtypeandshallcompriserigidweldedstruc turalframes enclosedcompletelywithcold rolled sheet steel of thickness no less than 2.5 mmfor front and rear portions and 2.0 mm for sides, top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. Stiffenersshallbeprovidedwherevernecessarytostrengthenthedoorandsidecovers.

All doors, removable covers and panels shall be gasketed all round with neoprene gaskets, exhaust fans,ventilatinglouversshallhavescreensandfilterstoheatdissipation.Thescreenssh allbemadeof either brass or GI wire mesh.

Design,materialselectionandworkmanshipshallbesuchastoresult inaneat appearanceinsideand outside with no welds, rivets or belt heads apparent from outside, with all exterior surfaces true and smooth.

Painting

All sheet steel work shall be phosphate coated in accordance with the following procedure and in accordancewithIS:6005“CodeofPracticeforPhosphatecoatedIronandSteel”Oil,gre ase,dirtand swarfshallbethoroughlyremovedbyemulsioncleaningRust andscaleshall beremovedbypickling with dilute acid followed bywashingwith runningwater,rinsingwith slightlyalkaline hot water and drying.

Afterphosphatecoated,thoroughrinsingshallbecleanwaterfollowedbyfinalrinsingw ithdilute dichromate solution and even drying.

Thephosphatecoatingshall befollowedbytheapplicationoftwocoatsofreadymixedstovingtype zinc chromate

primer. The first coat may be “flash dried” while the second coat shall be stoved.

Afterapplicationofthetwocoatsofprimerfinishingsyntheticenamelpaintshallbea
pplied,each coat followed by stoving. The second finishing coat shall be
applied after completion of tests.

Thefinal finishedthicknessofpaintfilmonsteelshallnot
belessthan80micronsandshall not be more than 100 microns.

Finishedpaintedsurfaceofpanelsshallpresentanaestheticallypleasingappearancef
reefromdents and uneven surface.

Asmallquantityoffinishingpaintshallbesuppliedforminortouchinguprequiredatsit
eafterthe installation of the panels.

BinsandPrintedCircuitCards

Individualbinsshallbemountedonaswingableframesothattheconnectionsattherea
rarealso accessible.

Self-
retainingthumbheadscrewsshallbeneededforholdingthebinsinposition.Adequaten
umberof card/ binextendersfortestingofPCBsshall
beprovided,eachwithflexiblecablesatleasttwometers long. These extenders shall
be of a universal type suitable for use with any card / bin as the case may be.

Alladjustmentswhicharetobemadewhilechangingacardshallbeoutsideinaseparat
emodule preferably plugged into the regulator bin.

Locking of individual cards in a bin shall preferably be through self-retaining
thumb-head screws. Control modulesshall be intheformof plug-in packages,
plugged into a modulebin.Each plug-in
unitshallconsistofastrongframeonwhichaprintedcircuitboardwouldbepermanentl
yscrewed. The plug connections shall only be of the pin type.

The printed circuit board (PCB) shall be made of glass fibre filled with epoxy
laminates. The plug-in unitshallbescrewedtothebasicsocket
inthemodulebinwithlongthroughboltsandknurledheads.

Thefrontplatesoftheplug-
inunitshallhavetheswitches,thepotentiometers,miniaturemonitoring meters, test
points etc. Each plug-in unit shall have its own identification legend.

Allplug-inunitsshallbepolarizedtopreventincorrectinsertionsintothemodulebin.

Thegapbetweentwoplugsinunitsinsideabinshallbesufficienttopermitadequate
ventilation.

Thecoppersideoftheprintedcircuitboardshall belacqueredtoprevent
oxidation.Eachsideofthe printed circuit board shall have a shield cover to
prevent inter circuit and external interference.

ThePCBshallbemountedonPCBguidesfixedonstandardracksandtheshieldproperly

grounded. Control circuit test points shall be easily accessible for monitoring and maintenance.

Annunciation

The annunciate shall work on DC power supply with communication facility (RS 485 port) Fault and TripshallbeseparatelycommunicablewithPLC.Eachannunciatewindowshallhavet woLEDlights connected in parallel which operate at not more than 75% of their rated voltage. Window shall be arrangedinalogicalgroup.Theannunciateshallhaveamoduleconstructionwithglass epoxyplugin cards.

Electronichooter/Alarmbell/sirenshallbecontinuously rated,TheAnnunciatorshallhavethe following facilities:

(d) Firstinsequence,memoryreset.
(e) faultsshallbememorized.
(f) Test Feature.

Thereshallbeathree-tiersystemofprotectionand annunciation:

(d) Alarmbothaudibleandvisual.
(e) Warningwithdelayedshutdowntimedelaythroughatimerofrange0-60sec.
(f) Disturbance associated with failures of systems elsewhere with serial communication port.

Meters

Individualmetersshallbeprovidedforspeedreference,speedfeedback,currentrefere nce,current feedback, pulse output, and regulated power supply voltages.

AllmetersshallbeidenticalandfedthroughindividualbufferICamplifiers.Allmeterssh allbethe circular scale type having a full-scale deflection of 270deg. All meters shall conform to at least accuracy class 1.0

All meters with their individual buffer amplifier cards shall be housed in separate bin. It shall be recommendedthatthebufferamplifiersallbehousedonasingle/twocardsandthiscardbeits elf/ themselves housed in the regulator bin.

Sensitive signal leads in that case shall not have to traverse from one bin to another, only noise insensitivebuffer amplifieroutput leadsshallneedtogotothemeterbin.Selectorswitchesifused with any meters shall have pistol grip handles.

Wiring

Stranded,flexiblecoppercableof2.5sq.mmshall beusedforCT circuitsand1.5sq.mmforother control circuits. However, for PCB terminals 0.75 sq.mm tinned copper wire may be accepted.

Ultra-flexiblecablesshallbeusedforallconnectionsfromafixedparttoamovablemember.In

addition, a hanging loop of sufficient length shall be provided to avoid any cable stressing.

All terminalboardsforoutgoingconnectionsshallbeat aheight ofat least 250mmfromthecubicle floor, and preferably tilted at an angle of 45^0 to the horizontal for ease of connections. Similarly, connectionoftheincomingpower cablestothebusbarsshallbedoneat aheight ofatleast250mm from the cubicle floor.

ItemdesignationandlocationmarkingshallbeinlinewithIECrecommendations.

Devicelabellingshall beonitsfixedmountingandnotonthedeviceitselfsuchthat labellingremains even when the device shall be replaced. Metallic labels / paper labels or sticker shall be accepted.

Non-SegregatedBusDuct

BusEnclosure

- Theenclosureshallbemadeofaluminiumalloywithminimumthicknessof3mm.
- Stiffenersshallbeprovidedwherevernecessarytostrengthentheenclosure.
- Bus bar cross over shall be avoided and shall be suitably coordinated with transformer manufacturer and panel manufacturer by the contractor.
- Silicagelbreatherandspaceheaterwiththermostatshallbeprovidedas required.
- The entire bus duct shall be designed for indoor / outdoor installation, with a dust and vermin-proofconstruction.Busductinstallationsmeantforoutdoorapplicationshallbeof weatherproof construction and shall have degree of protectionbetterthanorequalto IP-55 Outdoor portionof bus duct shall be provided with rain hood.
- The inside of the bus enclosure shall be treated with a matt paint of dark colour, preferablyblack to facilitate efficient heat dissipation. The bare enclosure with above painting shall be designed so as not to exceed the temperature specified in IS:8084 and MS epoxy painted with outer shade of Epoxy paint of shade 631 of IS 5. Paint thickness shall be not less than 100 microns.
- Joints consisting of metallic expansion bellows shall be provided on the bus enclosure at following points:
  (iv) Atterminationsattransformers.
  (v) Atterminationsatswitchgearcubicles.
  (vi) Intherunofthebusductincaseoflonglengthsasrequired.
- Flexible expansion joints for the enclosure shall be provided wherever deemed necessary. The flexible joints shall take care of expansion and contraction due to temperature variations and fault conditions.
- Necessary bonding shall be provided at the above expansion joints if joints are made of insulating material.
- Three-phaseterminal enclosuresshall beprovidedwithflangedendswithdrillingdimensionsto suit the flange at equipment terminals.
- Theflangesshallbeprovidedwithgaskets,nuts,bolts etc.
- Provision shall bemade forperiodicinspectionofinsulatorsbymeans ofinspection covers.The inspection covers shall be provided at the bottom

with quick-acting stainless-steel clamps and shall have gaskets. There shall be no joints or fixing bolts on the top surface through which water could seep through.

- Thedrainplugsshallbeeasilyremovableforcleaningpurposes.
- The gasket material and thickness shall be so selected as to satisfy the operating conditions imposed by temperature, weathering, durability etc. Care shall be exercised to ensure thatcovers fit easily, that the required compression of the gaskets can be obtained without damageto the inspection covers by bolts and that covers do not bend after this compression has been applied Over-compression of the gaskets shall be avoided.
- Thematerialofthegasketshallpreferablybeneopreneclosed-cellspongerubberor equivalent.
- Flangegasketsshallbeprovidedattheequipmentterminal connections.
- The bus duct shall not have any through bolts. All nuts and bolts shall be mild steel hot dip galvanized GS spring washers shall be provided for making satisfactory joints Clamps, splice plates etc shall be provided wherever necessary.
- Wheneverthe outdoor portion of the bus duct shall beof flanged construction butof boltedtype acontinuoushoodmadeofnon-magneticmaterialshallbeprovidedovertheentirelengthofthe outdoor portion of the bus duct to prevent ingress of water particles due to heavy rain fall directly on bus duct enclosure. This hood shall be mounted on bus duct supporting structuresand all hardware and accessories required for mounting the hood shall be included in scope of supply.

BusConductor

- ThematerialoftheconductorshallbeofECgradealuminiumalloy.
- Thetemperature rise of conductor shall be as per IS:8084. Also,the temperature of the bus shall not exceed 250˚C while carrying the specified short circuit current for one second when a fault occurs at the operating temperature.
- The bus conductor shall be given a coat of matt black paint to facilitate heat dissipation. The bare conductor with above painting shall be designed to carry the normal rated current without exceeding temperature rise as specified in IS:8084.
- Bus bars shall be colour coded with colour PVC tape at suitable intervals for easy identification.
- Flexible aluminium connectors welded to the main busbars shall be provided wherever deemed necessary.
- Theconnectors shall be of the same material as the conductor andjointsshall besilver-plated to ensure an efficient connection. The bolting schedule and contact pressure shall conform to accepted codes of practice.
- Flexible braided copper connections shall be provided at the equipment terminal such as transformer end and PCC / MCC end connections. Bimetallic connectors shall be provided between the busbar and the copper flexible if the bus conductor shall be of aluminium alloy.The joints shall be capable of 25 mm settlement of the equipment mounting pads. The joints shall be suitably designed to take care of the vibration at the terminals as well as the expansion and contraction of the busbars.
- Expansion joints made of aluminium strips shall be provided wherever deemed necessary, to take care of expansion and contraction of the

busbars under normal operating conditions.

- All the abovejoints shall be testedfortemperature rise to prove the adequacyof the design.The maximum temperature rise at the joints shall be less than the specified temperature rise for the busbars.

- The busbar clamps at insulators shall be designed to withstand the forces due to momentary short circuit current. They shall permit free longitudinal movement of the bus bars during expansion and contraction. The material of the clamps shall be aluminium alloy Suitable aluminium spacers shall be provided wherever necessary.
- All bolts, nuts and lock washers used in the bus assembly shall be of high tensile steel, platedfor corrosion resistance spring washers of “Beleville” type or equivalent shall be used.
- Suitablespliceplatesandbimetallicconnectorsshallbeprovidedwherevernecessary.
- Disconnecting links with rating same as that of the main busbars shall be provided in the run of the bus duct to facilitate disconnection of the busbars during testing and maintenance. The separation of the busbar sections with the bolted links removed shall be sufficient to withstand the rated voltage of the bus duct.
- Shorting jumpers, for the purpose of drying out the equipment before commissioning or for carrying out short circuit test on the equipment, rated for the main bus current shall be supplied for shorting the bus duct at a location, adjacent to the disconnecting links.
- The shorting links shall have drilling dimensions matching those of the main bus disconnecting links. Suitable supporting structures and support insulators for the shorting links, if necessary, shall also be offered.

PhaseBarriers

- In segregated phase bus duct if metal barriers are provided, the material shall be same as that of the bus duct enclosure material.
- Insulated phase barriers, when specified, shall be made of non-hygroscope insulating material such as fibre glass

BusSupportInsulators

- Within the bus duct the bus shall be mounted and supported on insulators. The insulators shallbe mounted on resilient pads provided in the bus enclosure.
- Theinsulatorsshallbeeitherporcelainorresincastflameretardant,non-hygroscopic,high creep and high strength type.
- For bus ducts with voltage rating up to 1100 Volt, Fibre glass / FRP or equivalent type of non- hygroscope insulating supports are acceptable.

WallFrameAssemblyandSeal-off Bushing

- Wherever the bus duct passes through the plant building wall, from indoors to outdoors, a wall frame assembly with seal-off bushings shall be provided to prevent any leakage of rainwater, infiltration of dustand air temperature variations fromindoors to outdoors.The wallframe shall be fabricated out of aluminium angles and sheet and shall be suitable for grouting in the wall. It shall be provided with flanges on both sides to receive the bus duct flanges. A suitable size breathershallbeprovidedforthetwosectionsofthebus-ductbetweenthewallframeassembly.

- The bus duct shall be equipped wherever necessary with seal-off bushings to preventinterchange of air at different temperatures. The seal-off bushings shall be flanged type.

- The insulator for wall frame assembly and seal-off bushings shall be of porcelain. Also, the bushings shall be designed for thermal expansion / contraction due to temperature differentialfor outdoor / indoor use.

BusDuctSupports

- The supporting structure shall be fabricated from standard steel sections and shall be hot dip galvanized after fabrication. The hot dip galvanizing shall be in accordance with standards.
- Calculations shall be furnished to substantiate the strength support structure to withstand the various static and dynamic loadings.
- The supporting structures shall include supporting members, brackets, hangers, longitudinal beams, channels, nuts, bolts, washers and all other hardware. which are necessary for the erection and support of the entire bus duct installation. All the accessories and hardware of ferrous material shall be hot dip galvanized.
- Studs, nuts, bolts and tapped holes shall conformto the relevant standards. Only hexagonal nuts shall be used. All bolt holes shall be spot faced for nuts.
- Castings and forgings shall conform to respective material specifications and shall be free from flaws. They shall be machined true as per good workshop practice. Welding shall be performed in accordance with relevant recognized standards.
- All threaded pipe connections and fittings, pipe flanges and tube fittings shall comply with relevant standards.
- Indoorportionofthebusductmaybesupportedfromthefloororceilingbeams.
- Outdoor portion of the bus duct shall be supported from ground below on suitable foundation in the ground.
- The foundations and structures in outdoor area shall clear the transformers, transformer foundations, cable trenches.
- All the bus supports shall be adequately supported and braced to successfully withstand normal operation, vibration, thermal expansion, short circuit forces and all specified design loads.
- A separate run aluminium alloy of suitable size clamped along both sides of the enclosure shall be provided as the earth bus. All the parts of the bus enclosure, supporting structures and equipment frames shall be bonded to earth bus. at least two earth pads shall be provided to connect the riser fromstation earthing bus. All necessary hardware, such as clamps, connectors, etc required for this purpose shall be furnished by the BIDDER.

ElectricalMotors

General

ElectricmotorsshallcomplywithIS12615, IS15999,BS4999andBS5000,IEC60034,IEC60072 and IEC 60085 and shall be bi-directional and rated on the basis of duty type S1 (maximum continuous rating).

Wherethepowersupplypermitsmotorsshall bepreferentiallyofthe3-phasetype.Motorsshall be suitablefortwostartsinsuccessionfromhotunderthespecifieddutyconditionsoflo

adtorqueand inertia and shall also be suitable for six equally spaced starts per hour under similar conditions.

Motorsshall be designed tooperateon the supplyvoltage specified for the Works.Motorsshall be capableofoperatingunderconditionsofthreephasesupplyimbalancewherethenegativeandzero

phasesequencecomponentsofthevoltagedonotindividuallyexceed2%ofthepositive phase sequence components.

ApplicableStandards

SL.NO.	BRIEFNAME	REFERENCE STANDARDS
24.	EnergyefficientInductionmotors–Threephase Squirrel Cage	IS–12615/IEC60034-30-1
25.	Standardmethodsfordeterminingglossesand efficiency from tests	IS-15999(Part2/Sec1)
26.	Permissiblelimitsofnoiselevelforrotatingel ectrical machines	IS–12065/IEC60034-9
27.	Mechanicalvibrationofrotatingelectricalmac hines	IS–12075
28.	GuidefortestingthreephaseInductionmotor s(For standard TEFC SCR motors)	IS–4029
29.	Methods of determination of efficiency of rotating electricmachines(ForstandardTEFCSCRm otors)	IS–4889
30.	Coloursforreadymixedpaintsandenamels	IS–5
31.	Electricalinsulation-Thermalevaluationand designation	IS–1271
32.	Dimensionsofsliderailsforelectricmotors	IS–2968
33.	Dimensionsofverticalshaftmotorsforpumps	IS–2254
34.	Valuesofperformancecharacteristicsforthr eephase induction motors	IS–8789
35.	Guidefortestinginsulationresistanceofrotat ing machines	IS–7816
36.	Designationfortypeofconstructionandmou nting arrangement of rotating electrical machines	IS–2253
37.	Guide on effects of unbalanced voltages on the performanceofthreephasecageinductionm otors	IS–13529
38.	Guideforselection&applicationofthreephas e induction motors for different types of driven equipment	IS–13555

39.	Codeofpracticeforinstallationandmaintenanceof induction motors	IS900
40.	DimensionsoffootmountedACInductionmotor.	IS-1231
SL.NO.	**BRIEFNAME**	**REFERENCE STANDARDS**
41.	DimensionsofflangemountedACInductionmotors	IS–2223
42.	Rotatingelectricalmachines–rating&performance	IS-15999/IEC60034-1
43.	Degreeofprotectionprovidedbytheintegraldesignof rotating electrical machines (IP code): classification	IS/IEC60034-5
44.	Designation of method of cooling for rotating electricalmachines/methodofcooling(ICcode)	IS6362/IEC60034-6
45.	Terminalmarkingsanddirectionofrotationfor rotating electrical machines	IS/IEC60034-8
46.	Dimension&outputratingofrotatingelectrical machines	IEC60072-1

Construction

Motorconstructionshallprovideadegreeofprotectionasfollows:

IP55-

useinapplicationsindustyenvironments.

IP 65 - external use in exposed location.

Motormountingarrangementshallbetosuit application.

Motor coolingshall betotallyenclosedfan cooled (TEFC) withshaftdriven bi-directional fans.Type ofcoolingshallbeIC411asperapplicablestandard.Otherformsofventilationmaybeusedwiththe approval of the Engineer.

Motor bearings shall be provided with facilities to add additional lubricant. For grease lubricated bearings grease nipples shall be provided and a grease relief feature incorporated. Oil lubricated bearings shall be provided with site glasses which provide an accurate indication of bearing oil level when the motor is in use. Bearings shall minimum L-10 rating of 5 years (40,000) hours at rated operatingcondition.Motorsratingof37kWandaboveshallhaveonlinegreasingfacilit

yandratings below shall be provided with sealed bearing.

Stainlesssteelratingshallbeprovidedwithinformationofratings,typeofenclosure,startingcurrent, startingtorque and efficiencyclass.Separatetagplatesshall beprovided for spaceheater,thermistor, RTD.

MotorsshallbedesignedfornormalsoundpowerasdefinedbyIS12615,IS15999,IEC60034orBS 4999 and windings shall be insulated to class F as defined by IS 11182 or BS 2757. However, temperature rise at full load shall be limited to that for Class B insulation.

Wherespecifiedmotorwindingsshallincorporate:

- Thermistors(PTCtype),or
- Resistancethermometers(PT100).

In each instance the temperature detectingdevices shall bein close thermal contact with each phase of thestatorwindings.Allthermistorsshallbeconnectedtogethertoprovideasingleelectricalcircuitfor connection to an external relay which shall be capable of tripping the motor.

Eachresistancethermometershallbeconnectedseparatelytoanexternalmonitorrelaywhichshall offeralarmandtripsettings.ThermalprotectionshallbeClassIforsizesofmotorupto75kW and Class II above 75kW.

PerformanceandCharacteristicsofLTMotor

(x) Motorsshall be capable ofgivingrated output withoutreduction in the expected lifespan when operated continuously under either of the following supply conditions:

Supply Condition	
(d) Variationinsupplyvoltage from rated voltage	±10 %
(e) Variationinsupplyfrequency from rated frequency	±5%
(f) Combinedvoltage and Frequency variation	+10%

(xi) All Motors shall be suitable for the method of DOL starting or star-delta starting or any other method of starting.

(xii) Theminimumpermissiblevoltageshallbe80%oftheratedvoltageduringmotor starting.

(xiii) Motors shall be capable of starting and accelerating the load with the applicable method of starting, without winding temperatures reaching injurious levels, when the supply voltage shall be in the range of 85% of the rated motor voltage to maximum permissible voltage.

(xiv) The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerances as per the applicable standard) unless otherwise specified. The locked rotor currentof VFD controlled motor shall be within the limit of IS 12615 / IEC 60034.

(xv) Motors shall be capable of developing the rated full load torque even if the supply voltagedrops to 70% of the rated voltage. The pull-out torque of the motor shall be at least 205% offull load torque.

(xvi) Motors when started with the driven equipment coupled shall be capable of withstanding at least two successive starts from cold conditions & one start from hot condition withoutinjurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.

(xvii) MotorsshallbeofEnergyEfficienttype.

(xviii) LTmotorsshouldhavethefollowingprovision:
ForMotor>=30kW,anticondensationheatersandseparateauxiliaryterminal boxforheaters shall be provided.

Motorsrated below 30kW,duringidleperiods, the stator windingshall be connected toa 24V 1-phase 50 Hz, AC supplyfor heatingand eliminationof moisture. The bidder / manufacturer shall bringoutincaseofanyobjectionto the above method of heatingstatingreasons thereof. Awarninglabel,blacklettersonayellowbackgroundshall befittedtoindicatethat theheater maybeenergised.Heaterterminalsshallbeshroudedonlargermotorsaseparat eterminalbox shall be provided.

Anti-condensation heaters shall be sized to raise the temperature inside the motor several degreesabovethedewpointtemperature,theheatersurfacetemperaturesh ouldnotexceed 200℃. Heaters shall be automatically disconnected when the motor shall be switched on.

(b) Vibrationmonitoringsystemshallbeprovidedformeasuringvibrationinmotorb odyand bearing for Motors > = 75 kW.

SpecificRequirementsofVFDDrivenMotors

The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequencyinverterforspeedcontrol.Themotorshallbesuitableforthecurrentwavefo rmsproduced by the power supply including the harmonics generated by the drive. The motor shall be designed to operate continuously at any speed over the range of rated speed.

Thepermittedvoltagevariationshouldtakeintoaccountthesteadystatevoltagedropa crosstheAC drive and all other system components upstream of the motor. The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.

Thedrivenequipmentmanufacturershallbesolelyresponsibleforproperselectiono fthemotorfor the given load application and the output characteristics of the driven equipment

LocalPushButtonStation

ForallmotorsLocalPushButtonstationshallbesuppliedshallbeprovidednearthemotor s/apparatus for controlling supply to the motor apparatus at an accessible location. For local control of motors, LPBS shall be provided suitable for wall / pedestal mounting. The Local Push Button station shall be complete with all the indication lamps, pushbuttons and shall have the specifications as listed below.

The degree of protection for LPBS shall be IP55 with canopy for outdoor and IP54 for indoor applications.Theenclosureshall bemadeof2mmCRCAsheetsteelandtheinteriorandexteriorof push button stations shall be painted light grey with shade no 631 of IS:5 as per standards.

Minimum Push button for ON / OFF / E-Stop and Local / Off / Remote Selector Switch and indicationlamps(ON/OFF/TRIP)shouldbeprovided.Reversepushbuttonshallbeprovidedfor bi-directional motors. The Emergency push buttonshall be of red mushroomhead, press to lock & turn to release type.

All push buttons shall be provided with 2 nos. NO and 2 nos. NC contacts for various interlocking purposes.OnecontactofstopPBshallbedirectlywiredtotheswitchgearmodulefordirecttripping and another contact to control system.

The stations shall have sufficient number of terminal blocks with 20% spare. The wirings shall be donewith1.5Sq.mm, multistrandcopper,1.1kVgradePVCinsulated,greycolour,highlyflexible wires having ends provided with identification ferrules and crimped tinned copper logs. Suitable plugs are to be provided to seal the unused cable entry opening. The glands shall be double compression brass type and shall be weatherproof. The local Push button shall be mounted at 1200mm from the floor level.

ThePBstationshallbesuitableforwallorstructuremounting,providedwithlabels, earthing terminals, suitable lugs glands.

PBstationshallbeofoneofthefollowingtypes

Type A - ThreePB'sforward-reverse-Stopforreversiblemotors. Type B - Two PB's start-stop for non-reversible motors.

TypeC - OnePBSTOPfor emergency.

CableTerminations

CableterminationboxesshallhaveIP55andshall besuitableforairterminationofcables.Theyshall be sealed with a neoprene gasket to provide dust and weather protection. Terminal box shall be suitable for top and bottomentryof cables and shall be capable of rotation in steps of 90 Deg through 360 Deg.

Cable boxes for voltages in excess of 1000 shall be treated with anti-tracking varnish.

Separateterminalboxesshallbeprovidedforspaceheater,thermistorwithcautionplates. When single core cables are used, gland plate shall be non-magnetic material.

JunctionBoxes

ForLTmotorsof18kWandabove,powerjunctionboxesshallbeprovidedwhere3corealuminium shall be terminated, and copper flexible cables shall be taken from it to the motor terminals.

ThedegreeofprotectionforJBshall

beIP55foroutdoorandIP54forindoorapplicationswith20% spare terminals.

Cables:MV,LV Power,ControlandTelecommunications

ApplicableStandards

Thecablesshallconformtothelatestapplicablestandardsspecified below

SL.NO.	ITEM	
1.0	**APPLICABLESTANDARDS**	
1.1	Typeof conductor	IS8130 IEC60228
1.2	ConductorScreening	IS7098 IEC60502
1.3	Insulation	IS5831 IS7098 IEC60502
1.4	Armouring	IS3975
1.5	Testandtest equipment	IS 10810
1.6	OxygenIndex test	ASTM-D-2863
1.7	Temperatureindex value	ASTM-D-2863/NES715
1.8	Cable drums	IS 10418
1.9	Flammability	IS 10810 IEC60331IEC 60332
1.10	Testforsmoke generation	ASTM-D-2843
1.11	Testforacidgasgeneration	IEC60754-1
1.12	TestsforResistancetoUltraviolet Radiation	DIN53387
1.13	Telecommunication cable, Low frequencycablesandwireswithPVCinsulationandsheath -GeneralTestsandmeasuringmethods	IS5831 IEC60189-1 IEC 60189-2
1.14	Instrumentationcable	IEC60189-1IEC60189-2
1.15	Construction,performanceandtestingof XLPE Insulated MV Power Cables	IS7098 IEC60502
1.16	Construction,performanceandtestingof 1100V Grade PVC Insulated Power and Control Cables	IS1554 IEC60502
1.17	Construction,performanceandtestingof 1100V Grade light duty unarmoured cables	IS694
1.18	Instrumentcableforoperatingtemperatureup to	JSS51034

SL.NO.	ITEM	
	400 deg centigrade	
2	InstallationofCables	IS1255
3	RecommendedCableRatings	IS3961

FeaturesofConstruction

(d) XLPEInsulatedMVallaluminiumstrandedPower Cables:
The Cables shall be 11kV unearthed grade, heavy duty, stranded aluminium Conductor, grade H4, Class 2, XLPE Insulated, Conductor Screening by extruded. Semiconducting compound, insulationscreeningthroughcombinationofsemiconductingcompoundandnon-magnetictape (Copper tape), inner sheath over laid up cores, galvanized steel wire / strip armoured (Aluminium wire armouring for single core cables), outer sheath of extruded black PVC Compound type ST-2 Core Identification shall be by printed numerals.

(e) LT Power CablesXLPEInsulatedCables:

TheCableshallbe1.1kVGrade,gradeH4,Class2,heavyduty,strandedaluminiumforabove 6 sq.mm, annealed Copper Conductor class 2 for 6 sq.mm and below, XLPE, insulated, inner sheathed, galvanized steel wire / strip, armoured, extruded black PVC Compound type ST2 outer sheathed.

(f) ControlCables:
The Cables shall be 1.1kV grade, heavy duty, stranded copper conductor, extruded PVC CompoundtypeAInsulated,galvanizedsteelwire/striparmouredwithextruded PVCinner sheath and extruded black PVC type ST1 outer sheathed.

CableRating

TheContractorshallensurethatcableandwiresassociatedwiththedistributionandcontrolsystems, plant wiring and all other installations throughout the works are adequately rated for their use.

Inassessingtheratingofanycableorwire,thefollowingfactorsshallbetakeninto account:

- Supplyvoltageandfrequency:
- Maximumvoltagedroppermissible.
- Typeandmagnitudeofload.
- Faultlevelanddurationrelatedtocircuitprotectionrelaysandfuses.
- Circuitovercurrent protection.
- Routelengthanddispositionof cables.
- Ambienttemperature.
- Methodofinstallation.

Allpowercablesshallbesizedforcontinuouscurrentcarryingcapacityattheambientt emperatureof 45^{0}C. The design current capacity of any circuit shall not exceed the full load current of the supplied device by at least 10%. Power cables shall be sized to limit the maximum voltage drop to not more than 3%.

Under motor starting conditions the corresponding voltage drop shall not affect the operation of the motor controls or the ability of the motor to start and run effectively and in any event shall not exceed 10%. The Contractor when sizing cables for the remote operation of shunt trip coils shall take due accountofthevoltagedropcausedbythemomentarycurrentsurgetakenattheinstanto fenergisation. MV and LV cables shall be sized for a fault clearance time of 1 second for the incoming feeders and 0.5secondforswitchboardfeederscontrolledbycircuitbreaker.

CableColours

All cable cores shall be colour coded throughout their length and shall be so connected between switchboard,distributionboard,plantandaccessories,thatthecorrectsequenceorph asecoloursare preserved throughout the system.

Thecolourcodingshouldbeasfollows:

3 phase	red,yellowandbl ue
singlephaseordc	redandblack
earth	green/ yellow
control	blue(dc),red(ac)

CableConductors

Copperconductorsshallbeusedforcablesofsizesupto6Sq.mmandabove6Sq.mmAluminiu m conductors shall be used. Cores of cross-sectional area greater than 1.5 Sq.mm shall be stranded.
Lightingfinaldistributioncircuitsshallbeofaminimumcross-sectionof1.5Sq.mm.Powercables shall be of a minimum cross-section of 2.5 Sq.mm. Internal wiring of control panels shall be of a minimum cross-section of 1.0 Sq.mm flexible and stranded Control cables shall be of a minimum cross-section 1.5 Sq.mm for external use and 1.0 Sq.mm for internal use.

CableNumbering

All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosionresistantlabel.Cablesofdifferentcategoriesshallbetaggedwiththefollowi ngsubscripts and three-digit number

MVpower	MV-P___

LV power	P_ _ _
Control	C__ _

Instrumentation	I___
Protection	PR___

CableDrums

Cables shall be supplied in non-returnable wooden drums and shall confirm to IS 10418-2024. The wood used for constructionof the drum shall be properly seasoned and free from defects and wood preservativeshallbeappliedtotheentiredrum.Allferrouspartsshallbetreatedwitha suitablerust preventive coating to avoid rusting during transit or storage.

The Bidder shall indicate in the offer, the maximum length for each size of cable, which can be suppliedononedrum.Theactuallengthsuppliedoneachdrumshallbewithintolerance limitof ±5% without any tolerance on total ordered quantity of each size of cable. However, before winding the cables on drums contractor shall obtain Employer’s approval for the drum lengths.

Each drum or coil of cable shall be accompanied by a certificate stating the manufacturer's name, cable size and number of cores, length, result and date of tests as required in the Employer’s Requirements. Cables manufactured more than 12 months before delivery shall not be accepted. All cablesshall bedeliveredwithcableendseffectivelysealedbyhygroscopicscalingcaps.Whenacabl e is cut from a drum both ends shall be immediately sealed to prevent ingress of moisture. Cables shall not be transported to site in loose coils but a number of short lengths of cable may be transported on the same drum. The Contractor shall be wholly responsible for the purchase and / or hire costs of all cable drums and for the removal of these drums from site after use.

CableInstallation

General

Cablesshallbeinstalledinsuchawaythattheminimumbendingradii arenot reducedwheninstalled or during installation. Cables shall not be installed in ambient temperatures below that recommended by the cable manufacturer.

Cablesgroupedtogethershallhaveinsulationcapableofwithstandingthehighestvolt agepresentin the group.

Cablefiresealingshallbeprovidedsuchthatfireproofcablepenetrationsealsratedfort wohoursshall be provided as per BS: 476 (Part - 20) or equivalent standards.

Cablesofdifferentcategoriesshallbeinstalledsoastomaintainsatisfactoryclearance sforsafetyand in ordertoreducethe possibilityofelectricalinterference.Thefollowingtable detailsthedistancesin mm that shall be maintained between the different categories of cable.

TableofSeparationDistancesinmmbetweendifferentCategoriesof Cable

CableCategory	MV Power	LVPower	C&I/Protection

CableCategory	MV Power	LVPower	C&I/Protection
MVPower	Notspecificbutshall suit de-rating factor	300	600
LV Power	600	Notspecificbutshall suit de-rating factor	300
C&I/Protection	600	300	Notspecificbutshall suit de-rating factor
Gas/Watermain	300	300	300

Theseseparationsareminimumandspecialcircumstancessuchasthepresenceofhigh currentflows, or harmonic content may necessitate larger separation distances.

Inordertomakeeconomicuseofthecablesupportsystem,cablesshallbearrangedingroups of50 mm maximum overall diameter. These groups shall be securely tied to the cable support system at intervals not exceeding 900 mm for horizontal runs and 300 mm intervals on vertical runs.

Cablesshallbelaidinamannersuchthatanyelectricalinterferencebetweencablesshallnot havea detrimental effect on the life and operation of Plant.

Where practical a separate cable support system shall be provided for power and non-power cables.
Wherethisisnotpracticalaseparationof150mmshallbemaintainedbetweenpoweranddnon-power cables when run on the same support system.

Heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems. Plastic or GRP cable support systems shall be used in areas used for the storage and handling of chlorine.These systems shall be used toroutecablesaround wallsand within cable trenches. Cables shallbesecurelyfixedtothesupportsystemsBundlingofcablesshallbepermittedwhereallowance for this practice has been made in sizing the cables.

CablesLaidDirectin Ground

Buried cable up to 650 / 1100V shall have a minimum cover of 750 mm measured to the top of the highest cable. On crossing roadways, the cable shall be run through a PVC-U duct of minimum diameter100mmwith aminimumof1000mmcover andencasedonallsidesby150mmofconcrete. Cables of greater than 650 / 1100V shall be buried with a minimum cover of 1 m.

Thebottomofthecabletrenchshall befreedofsharpstonesandsuchlikeand75mmofsievedsand laid below the cable. After cable laying 75 mm of sieved sand shall be laid above the cable. Interlocking cable protective covers, minimum 1 m long x 300 mm wide, marked ‘Danger -Electric Cable’ in English and the vernacular shall be laid on top of the

sieved sand covers shall extend the wholelengthofthecabletrenchandshalloverlapcablesbyaminimumof50 mm.Warningtapeshall be laid a minimum of 200 mm above the protective covers. Cables are to be installed without tees or

throughjointsunless otherwiseapprovedbytheEngineerSinglecorecablesshallberunintrefoil formation.

CablesLaidinUndergroundDucts

Underground ducts shall be constructed of impact resistant PVC-U and laid at a minimum depth of 500mm,ductsshall besurroundedbyatleast 75 mmofsievedsandexceptatroadcrossingswhereit shall be 1 m deep and encased on all sides by 150 mm of concrete.

TheContractorshallensurethatsufficientdraw-inpointshavebeenprovidedandthatadequateroom has been allowed for installation of cables. Drawstrings shall be provided in all ducts to enable additional cables to be installed when required.

Wherecablespassinoroutofanyductentriesintoorwithinbuildingssuchentries,together with any spare ducts shall be sealed against the ingress of moisture by means of duct stoppers and bituminous compoundsor byanyothermethodapprovedbytheEngineer.Thestoppershall haveafireresistance of at least 30 minutes. Single core cables in trefoil formation shall pass through the same duct and shall not be separated.

Cablesinstalledin Conduit

(d) General

Conduits shall be galvanized heavy gauge solid drawn or welded screwed steel type and be in accordancewithIS9537Part2orBS4568.Accessoriesshalleitherbemalleablecast ironscrewed type or pressed steel and galvanized.

A space factor of 40% shall not be exceeded, but in any case, conduit of less than 20 mm diameter shall not be permitted. The tubing shall be perfectly smooth inside and out and free from flaws and imperfectionsofanykind.Bothendsofeverylengthoftubingshallbeproperlyreamed withallsharp edges removed before erection.

Whereseveralconduitsconverge,malleablecastironorheavygaugesheetsteeladaptableboxesshall be employed in order to avoid crossings. Conduits shall be connected by means of male brass bushes and couplings.

Where conduits are greater than 25 mm, straight through joint boxes shall be of the trough type. Where conduit and / or fittings are attached to equipment casings, the material or case of the casing shall betappedforadepthofnot lessthan10mmormalebushesandflangedcouplingsshall beused.

Heavy hexagonal lock nuts shall be used at all positions where running joints are required and great care shall be taken to ensure that they seat firmly and evenly on to the mating faces of coupling or otheradjacentaccessories.Alljunctionboxes,draw-inboxes,andinspectionfittingsshallbesoplaced that the cables can be inspected and, if necessary, withdrawn and re-wired throughout the life of the installation.

Generally,notmorethantwobendsoroffsetsoronecouplingshallbepermittedwithout asuitable inspection accessory. Fish wires shall not be left in conduits after erection. The whole of the

installation shall be arranged for a loop-in type of system with joints being carried out at switches, isolators,etcIntermediatejointsinthecableshallonlybeallowedbyarrangementwitht heEngineer. Where terminal blocks are necessary, they shall be of the porcelain type with brass pinching screws.

Ends of conduits which are liable to be left open for any length of time during building operations shallbepluggedtopreventtheingressofdirt,cement,etcandcovers,eithertemporary orpermanent, shall be fitted on all boxes.

Generally,conduitsshallnotcrossexpansionjointsofbuildings,butwheretheycannot beinstalledin any other manner then a flexible conduit shall be used across the expansion joint A total 150 mm movement shall be allowed.

(e) Surface Installation

Surfaceconduitsshallbesecuredandfixedbymeansofdistancespacingsaddlesorappr ovedpurpose made clips which allow the conduits to be taken directly into accessories without sets or bends.
Conduitsshallberuninasquareandsymmetrical manner.Anefficientmeansshallbeadoptedto provide for the drainage of condensation and the runs shall be properly ventilated.

All surface conduit runs shall be marked out for approval by the Engineer before the installation shall be carried out. Where large multiple parallel conduit runs would occur, use may be made ofgalvanized cable trunking. Conduits installed on structural steelwork shall be secured at spacing not exceedingthoseforsurfaceconduit bygirderclips,otherwisefixingshall beasforsurfaceconduitson walls, drilled and tapped to the metalwork Power driven fixings shall only be used with the express permission of the Engineer. Any drilling or access which shall be required through any structural member of the building shall be agreed with the Engineer before carrying out the work.

Exposed threads and places where galvanizing has been damaged shall be cleaned and then painted withtwocoatsofanapprovedmetalliczinc-basedpaint.Thistreatmentshallbeappliedasthework proceeds.

(f) ConcealedInstallation

Concealedconduitsshallbesecurelyfixedtopreventmovementbeforelayingofscreed s,floatingof plaster, casting of columns or other building operations necessary after the conduit installation.
Crampetsorsimilarfixingsshallbeusedforattachingtheconduittobrickwork,etc.Buil dingnails shall not be accepted.

At least 15 mm cover shall be allowed for finishes over the conduit. Where this cover cannot be maintainedthenexpandedmetalshallbefittedwiththeconduit. Conduitcastintoreinforcedconcrete floors shall be fixed to the steel reinforcing with binding wire and the conduit boxes filled with expanded polystyrene or enclosed in a plastic bag to prevent the ingress of concrete when poured. Wherepossible,theconduitboxesshallbefixedtoshutteringtogiveaflush finish.

Conduitinstalledinvoids,falseceilings,andotherconcealedroutesshallbeinstalledas specifiedfor the surface conduits. Wiring shall be carried out after the false ceiling or permanent ducts have been completed. Conduit installed in floors shall be sealed against ingress of moisture.

Theconduitinstallationshallbeinspectedbytheengineerbeforethebuildingoperation concealsthe work.

CableInstalledinFlexibleConduit

Flexibleconduitshallbeofthewaterproofgalvanizedtypeorpvcwire-woundtypewithcadmium plated mild steel couplings. Lengths of flexible conduits shall be sufficient to permit withdrawal, adjustment or movement of the equipment to which it shall be attached and shall have a minimum length of 300 mm. Flexible conduit shall not be used as a means of providing earth continuity. A singleearthconductorofadequatesizeshallbeinstalledexternaltotheconduitcomplete withearth terminations.

Whereconversionfromrigidconduittoflexiblemetallicconduitshallbemade,therigid conduitshall terminate in a through type box and the flexible conduit shall extend from this box to the equipment, the earth continuity cable shall be secured to the box and to the piece of equipment by properly designed earthing screws. The use of lid facing screws, etc. shall not be permitted. Adapters shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

CableInstalledinCableTrunking–Metal

Cabletrunkingshallbemanufacturedfrommildsteelofnotlessthan125mmandshallbe hotdipped galvanized. The Contractor shall ensure that the size of the trunking shall be adequate for the number of cables to be installed together with 50% spare capacity and shall in any case be 50mm x 50 mm minimum size.

Segregationofcablesshallbecarriedoutifrequiredusingcontinuoussheetsteelbarriers withthe bottom edge welded to the trunking.

The trunking shall have two return flanges for rigidity. Where necessary, additional strengthening straps shall be fitted internally. The cover shall overlap the trunking and be made of the same gauge. Fixingscrewsforcoversshallberecessedandbeoftheself-retaining`quickfix'type.All bends,tees and intersections shall be of the gusset type and shall, wherever possible, be purpose made by the manufacturer and of a matching design to the main trunking.

Cables shall be retained in the trunking when the cover shall be removed by means of straps. Internal connectingsleevesshallbefittedacrossjointsinthetrunkingandearthcontinuityensured bybonding each section of trunking to a continuous earth wire.

Non-flammable fire barriers shall be inserted where the trunking passes through walls or floors. Conduitconnectionstotrunkingshallbemadebyflangedcouplingsandmalebushes.Trunkingshall be supported at intervals not greater than 2 m horizontally or 25 m vertically. Crossings over expansion joints shall be made in flexible conduit.

Shoulditbenecessarytocut ordrill asectionoftrunkingoratrunkingfittingthebaredendsshall immediately be given a coat of zinc rich cold galvanizing paint.

Cable and conduit / trunkingruns shall be determined bythe Contractor and agreed bythe Engineer beforeanyworkshallbestarted.Therunshallbeatleast150mmclearofplumbingand mechanical services. Conduit / trunking systems erected outside a building shall be weatherproof.

CableInstalledonCableTray

Cable tray shall be of perforated sheet steel with formed flanges and of minimum thickness not less than 1.5mm for trays up to 100mm width, perforated / ladder type with minimum thickness not less than2mmfortraysabove100mmto300mmwidthand2.5mmfortraysabove300mmwidth.Exterior perforated cable trays shall be covered with cable tray covers.

Cable tray shall be hot dipped galvanized. Cable tray for use in areas where chlorine gas may be presentshallconstructfromU-PVCorGRPCabletraysupportsshallbeofacompatiblefinish with the associated cable tray.

Allcabletraytees,intersectionunits,bends,turnsandsetsshall,wheneverpossible,be purposemade by the manufacturer and shall be of a matching design to the main section of cable tray.

Trayshall onlybejoinedbycouplerssuppliedbythemanufacturers.Thejointshallbesecuredin accordance with the manufacturer’s instructions.

Cable tray supports supplied by a manufacturer or made up on site shall be of ample strength to maintainrigidsupporttothefullyladen cabletrayalongitsentirelengthandshallensurethatthe deflection of any one section does not exceed 15 mm at mid-span.

Wherever possible, cable trays shall be installed in full lengths without cutting. Should it be necessary to cut or drill a length of tray, then for galvanized trays, the bared ends or damaged section of the tray shallimmediatelybegivenacoatofzincrichcoldgalvanizedpaint.Allsitemanufactured accessories, supports and metal fittings required to ensure correct installation of the cable trays shall be similarly treated.

All cables shall be firmly secured to the tray using purpose made saddles, as approved by the Engineer, together with proprietary nylon fasteners and / or cable cleats. Following installation of cables, the tray shall remain rigidly supported and the deflection of any section shall not exceed 15 mmatmid-span.Allbracketsandtrayworkshallbesuitableforwithstandingatemporaryweightof 125 kg.

Cabletraysshallnotbecuttoallowthepassageofcables throughthesurfacesofthetray.Thesizing of the cable tray shall provide a minimum of 25% spare capacity. The tray shall be run at least 150 mm clear of plumbing and mechanical services.

CableInstalledonLadderRack Systems

Ladderrackingeitherlightor heavyweight shallbe proprietaryitemand installedin accordance with manufacturer'sinstructions.Bendsintheinstallationshalltakeaccountoftheminimumbendingradii ofcablestobeinstalled.Cablesshallbeclippedtotheladderrackusingclipsdesignedforthesystem in use andappropriateto the type andsize of cableinstalled.Thesizingofthecable racksystemshall

provideaminimumof25%sparecapacity.Theladderrackingshall berunatleast150mmclearof plumbing and mechanical services.

CableClippedDirect

Allcablehangers,clips,cleatsandsaddlesshallbeofanapprovedtypeandappropriate tothetype and size of cable installed. Their spacing shall be such as to ensure a neat appearance and prevent sagging of the cables at all times during their installed life.

CableInstalledinInternalFloorTrench

(c) InShallowtrenches(maximumdepth500mm)

Inshallowtrenchesusedforelectrical servicesonly,cablesmaybelaidinaneatandorderlymanner onthefloorofthetrench.Onelayer onlyshall beallowed.Additionalcablesshall beinstalledonthe walls of the trench in an approved manner. Here the trench shall be shared by other services, cables shall be installed on the walls of the trench in an approved manner.

(d) Allothertrenchesincludingwalkthroughserviceducts

Cabling shall be installed to the walls of the trench in an approved manner. Where other services are present the cables shall be segregated from them and wherever possible kept above 'cold' 'wet' services.Cablesshouldnotberun,ifatall possible,aboveor incloseproximityto'hot'services.The cabling shall be installed in such a manner as to allow access to the other services for normal maintenance without disturbance of the electrical installation.

CableTerminationsandJoints

(iv) **PowerCableTerminations**

Powercablesshallbeterminatedinsuitableboxesarrangedforboltingtoswitchgear ,motorstarters and motors. Coresshallhave either crimped lugs orsleeves to match eitherpost terminals or bolted clamp terminals.

Each cable entry into a terminating box shall be made through a suitable gland, which shall have provisionforsecuringthearmourwhereapplicable.Wheresinglecoreglandsarerequi red,theseshall be ofthenon-magnetictype and theassociatedbox bottomplate, wherethecorepasses through, shall not have a continuous magnetic path.

Adequateprovisionshallbemadetobondthecablearmouringtotheboxand/ orswitchgearcasingof a suitable size to withstand the prospective short circuit fault current of the system, glands shall be fitted with earth bonding tags where intimate screwed contact between gland and cable box shall not be possible.

Wherecableglandsareexposedtotheweatherthenseshallbeprotectedbyheatshrink plasticsleeveor purpose moulded sleeves covering the gland continuously from overall sheath to the gland neck.

Where terminations of multicore type have to be made on to items of plant which have to be dismantledformaintenance,theseshallbemadeoffthroughglandsintoanadaptable boxcontaining

terminalsandflexiblesinglecorestakenintotheequipmentviaflexiblewaterproofplas ticcovered conduit, and a separate earth core linking the box to the equipment.

Wherecablesareglandedtoorpassed throughcablingplatestheglandplateorcablingplateshallbe constructed of non-magnetic material.

(v) PowerCableJoints

Through joints shall only be allowed with the approval of the Engineer. Where such joints are necessary in thermoplastic and elastomeric cables, the cables shall be jointed with epoxy or acrylic resin cold setting compound, which has been premeasured and pre-packed ready for use. The boxes shallpreferablybeofsplit,mouldedplastictypewithfillingventsforcompound.Bondin gstrapsshallbe fittedwitharmourclampsacrossthejointandinspectedbytheEngineerpriortofillingth eboxwith compound.Wrappedpressuretypejointsshallnotbeaccepted.IncaseofHTcableendte rminationand straightthroughjointsshallbeapprovedheatshrinkabletype.Highvoltagetestshallbe conducted,and testreportsandmeggervaluesshallbesubmittedaftertestalongwithcalibrationcertifi catesofthe instrument used for measuring.

(vi) **MulticoreorControlCable Terminations**

A sufficient number of terminals shall be provided to terminate all cable cores including 10% spare cores.Forcontrolandauxiliarywiringanadditional20%ofthisnumbershallbeprovide dasspares.

Notmorethanonecoreofinternalorexternalwiringshallbeconnectedonanyonetermi nal.Where duplication of terminal blocks are necessary, purpose-made solid links shall be incorporated in the design of the terminal blocks.

Terminalswhichremainenergizedwhenthemainequipmentshallbeisolatedshall besuitably screened and labelled.

Terminalblocksfordifferentvoltagesorcircuittypeshallbesegregatedintogroupsanddisti nctively labelled.

CableFixings

Tiesandstrappingshall besuitableforsecuringcableandcablegroupstocabletrayorladder.They shall be resistant to chemical and marine corrosion Plastic coated metal ties used in order to obtain corrosionresistanceshallnot beacceptable.Nylontiesshall beresistanttotheeffectsofultra-violet lightandshallbeself-extinguishing.Largesinglecablesshallbesecuredwithcableclampsorcable cleats.

CableIdentification

At each end of each cable, in a uniform and visible position a label shall be fixed

on the cable in accordancewiththecableschedule.LabelsshallbemadeofPVCandshallbeindelibly markedtothe approval of the Engineer. The label shall be retained using proprietary nylon strips passing through two fixing holes at either end of the label. If the cable gland shall not be normally visible, then the label shall be fixed inside the panel by means of screws.

CableGlands

Glands shall generally be of the mechanical double compression hexagon type Earth continuity of brassglandsshallconfirmtoBS:6121/ EN50262.Thismaybeachievedbytherigidclampingofthe armour within the gland and the intimate contact between the threaded components of the gland and the equipment.

Each gland shall be installed complete with proprietary earth tag providing a ready means of connectingaflexiblestrandorstripearthbondtotheglandat anypositionaroundtheglandinrelation totheassociatedapparatus.Adequateearthcontinuityshallbeassuredbetweentheearthtag,thegland and the armour wires of the cable where applicable.

Glands for single core cables shall be constructed from non-magnetic materials. Each gland shall be installed complete with a proprietary non-ferrous locknut to secure the gland body to the equipment wheretheentryholeisplain,i.e.,nottapped.Whereholesforcableentriesarenot providedit shall be the responsibilityof the contractor to markout and drill such holes Burrs and swarf shall be removed, care being taken to ensure that swarf and filings, etc do not enter the equipment.

Fornon-hazardousareascableglandsinsituationswheremoisturemaybepresentshallbedoubleseal weatherproof type, gland shrouds shall be used, and entry shall be sealed. For dry indoor situations, standard industrial glands with shrouds are acceptable. For hazardous areas, glands conforming to EExd standard shall be used with double seal and shroud.

Powercableglandingarrangementsinhazardousareasshallincorporateaninsulated adapterandearth link.Thisshall providethefacilitytodisconnectthearmouringfromtheglandeddeviceinorderthat a true earth loop value may be measured when carrying out tests on the installation. Cable Glands shall be suitable for indoor and outdoor use, appropriate for single wire armoured, plastic or rubbersheathed cable. Which provides grip to the cable with outer and inner seals suitable for all climatic conditions weatherproof and waterproof. The outdoor cable glands shall be provided with shrouding.

MarkingLocationsofUndergroundCables

Thelocationofallundergroundcablesshallbeengravedonbrassorothernon-corrodibleplatestobe fixed to the exterior surface of all walls of buildings 300 mm above ground level and directly above the point where cables pass through the wall.

In addition, concrete route marker posts shall be installed at intervals of not more than 50 m at all junctions and changes of direction along the cable route and cable joint markers shall be provided

whereverundergroundingcablejointexists.Suchmarkerpostsshallbenotlessthan200mmhighand of substantial construction.

AdrawingorsampleofatypicalmarkerpostshallbesubmittedfortheapprovaloftheEngineer.The markers shall be marked ‘electric cable’ / ‘cable Joint’ in English and the vernacular.

DrawingsandData

All Drawings, data,technical particulars,calculations,detailed literature,catalogues, testcertificates etc,shallbesubmittedalongwiththebid/afterawardofcontractasspecifiedunder,“Bid/Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

CableCarrier System

General

Thecablecarriersystemcoversthesupplyofcableracks,cabletraysanditssupportingaccessories.

ApplicableStandards

Steelforgeneralstructuralpurposes : IS:2062

Dimensionsforhotrolledsteelbeam : IS:808

columnchannelandanglesections

Codeofpracticeforuseofmetal arc : IS:816

weldingforgeneralconstructioninmildsteel

Hotdeepgalvanizingofiron& steel : IS:2629

Methodsoftestinguniformityofcoating : IS:2633

ofzinccoated articles

onstructuralHotdipzinccoatings : IS:4759

steelandotherallied products

CableRacks,Traysandtheirsupport structure

(c) Cableracks/traysshallbefabricatedfromstandardstructuralsteelmembers.

(d) All cable trays, vertical raceways, cable racks and cable tray supporting structures shall be hot dip galvanized.

Galvanising

Wherever galvanizing has been specified, the hot dip process shall be used. The galvanized coating shallbeofuniformthickness.WeightofZinccoatingsforvariousapplicationsshallnotbelessthan those indicated below:

(b)FabricatedSteel	
Thicknesslessthan2mm,butnotlessthan12mm	340 gms/sqm
Thickness less than 5 mm, but not less than 2 mm Thickness 5 mm and over	460 gms/sqm
	610 gms/sqm
(c) Fasteners	
UptonominalsizeM10	270 gms/sqm
OverM10	300 gms/sqm

Galvanizing shall be carried out after all drilling, punching, cutting, bending and welding operations havebeencarriedout.Burrsshallberemovedbeforegalvanizing.Anysitemodification ofgalvanized parts such welded joints, fabricated cable trays and supports should be covered well by zinc rich primer and aluminium paint.

DrawingsandData

AllDrawings,data,technicalparticulars,calculations,detailedliterature,catalogues,testcertificates etcshall besubmittedalongwiththebid/ afterawardofcontractasspecifiedunder,“Bid/ Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

Lighting System

GeneralRequirements

LEDlightingshall beconsideredforindoorandoutdoorlighting.TheLightingsystemincludesthe following items

(iii) Lightingfixturescompletewith Lampsandaccessories(lumenperwattshallbeindicated).
(iv) Lightingsystemequipment(ISImake).

- Lightcontrolswitches,receptacleunitswithcontrol.
- Switch units, lighting wires, conduits and other similar items necessary to completelighting system.
- Lightingfixturesupports,streetlightingpolesandfloodlighttowers.
- MainLightingdistributionboard,lightingpanels.

- Multicorecablesforstreet,boundaryandfloodlighting.

LEDRequirements

- High Power White LEDs are used in the luminaries and the Wattage of these LEDs would begreater than ONE watt.
- LEDshallbeoperatedataforwardcurrentoflessthan90%oftherated current.
- ColourRenderingIndex(CRI)oftheLEDsusedintheluminaireshallbegreaterthan70.
- The illumination of the luminaries shall be uniform without dark bands or abrupt variations and soothing to the eye.
- Light Uniformity Ratio (E_{min}/ E_{avg}) shall be as per National Lighting Code, National building Code.
- LuminaryBodyTemperaturewouldbelessthan30degCabovetheambient,evena fter continuous burning of Luminary for 24 Hrs.
- TheLuminaireworksonsinglephasethreewiresystem(Phase,Neutral&Earth).

ConstructionofLEDluminaires

(c) The luminaire housing shall be made up of Corrosion free High Pressure Aluminium die cast thus confirming the luminaire to IP-65 protection and safety as per IEC 60598-1.

(d) The Luminaire shall be equipped with distortion free, clear, Heat Resistant toughened, UV stabilized glass cover in the front fixed to the die cast Aluminium frame which would be fixedto the housing by means of stainless-steel screws.

TheminimumtechnicalspecificationsforLEDlightingshallbeasfollows:

(xvii)PoweredbythelatestbrightLEDswithhighefficiencyandmeetingLM-80standard. (xviii)Average rated life span of 50000 hrs.
(xix) LEDlumenoutputshallbegreaterthan125Lumens/ watt.
(xx) Luminaries'lumenoutputofatleast80Lumens/watt.
(xxi) Inputvoltagerange90-300V.
(xxii)Powerfactor>09.
(xxiii) THD<15%.
(xxiv) IngressprotectionasperIP65.
(xxv)Operatingtemperature: -5°Cto50°C.
(xxvi) Storagetemperature:-5°to70°C.
(xxvii) Humidity10%-100%.
(xxviii) LEDsshallbeoperatedataforwardcurrentlessthan90%ofitsrated current.
(xxix) TheLEDsusedintheluminaireshallhaveminimumangleof120degree.
(xxx)Colourrenderingindex(CRI)oftheLEDsshallbegreaterthan70.
(xxxi) ConformtoPhotoBiologicalSafetyfortheLEDsasperIEC62471.
(xxxii) Freereplacementwarrantiesof5yearsfortechnicaldefects.

Applicablecodes&standards

Tests

ContractorshallsubmitallfollowingtestreportsforLEDlightingfixturesbeforedispatchingof material at site. All tests shall be carried as per IES approved methods defined (LM-82)

(h) LM-80formeasurementoflumenofLEDsource.
(i) LM-79forfixture-Electrical&Photometricmeasurement.
(j) TM-21testforLEDlife.
(k) ThermalCharacteristic-TestforLumenoutputtemperaturedependency.
(l) ElectricalCharacteristic -Testforthecalculationof efficacy.
(m) DrivertestingforPowerfactor,THD&Isolation.
(n) IPProtectiontestagainstingressofduct&solidobjectsforbothindoor&outdoorLED fixtures.

Earthing

(iv) Each luminaire shall be provided with an earthing terminal suitable for connection to the earthing conductor of 12 SWG GI wire.
(v) Where separate control gear box shall be provided for housing the accessories the same shall be provided with an earthing terminal suitable for connecting earthing conductor of 12 SWG GI wire.
(vi) All metal or metal enclosed parts of the luminaire / control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.

Painting/ Finish

(vi) All surfaces of the Luminaire / Control gear box housing accessories shall be thoroughlycleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.
(vii) When enamel finish shall be specified, it shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading.
(viii) The luminaire housing shall be stove-enamelled / epoxy stove-enamelled-vitreous enamelled or anodized as indicated under various types of fittings.
(ix) The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg over 1/2” dia mandrel.
(x) The finish of the luminaire shall be such that no bright spots are produced either by direct light source or by reflection. External control gear box provided for housing accessories shall be painted or galvanized.

ApplicableStandards

All light fittingsshall beenergyefficient typewithlumenperwatt shall bespecified.Thedesign, manufactureandperformanceofequipmentshallconformtothelateststandardsspecifiedbelow:

NationalLightingCode :SP

NationalBuildingCode :SP 7 - 2016

NationalElectricCode :SP30 - 2023

Codeofpracticeforindustriallighting :IS6665

Code of Practice for Interior Illumination

:IS364

6 2006 / 95 / EC, Low Voltage Directive (LVD).

2004/108 /EC, EMCDirective.

Codeofpracticeforlightingofpublic thoroughfare :IS1944(Part 1&2)

Light and lighting. Lighting of workplaces

:BSEN12464par

t1 Indoor workplaces

Light and lighting. Lighting of workplaces

:BSEN12464par

t2 Outdoor workplaces

EN50530,IEC62124,IEC61347-2-13, IEC62384,CISPR15,IEC61547,IEC60598

Electrical lighting fittings general and : IS:1913/

BS:4533

safetyrequirements

Calculation of co-efficient of utilization : IS:3646(Part-

III) Industrial lighting fittings with metal : IS:1777

Reflectors

Decorativelightingoutfits : IS:5077

Dustproofelectriclightingfittings : IS:4012

Dusttightelectriclightingfittings : IS:4013

Flood lights

: IS:10322/BS:4533

Luminairesforstreetlighting :

Watertightelectriclightingfittings : IS:3553/ BS:4533,5225(I)

Bayonetlampholders : IS:1258/ BSEN 61184/IEC:60061

Edisonscrewlamp holders : IS:10276/BSEN 60238

Bi-Pinlampholdersfortubularfluorescentlamps : IS:3323

Startersforfluorescentlamp : IS:2215/ BSEN60155

Holders for starters for tubular fluorescent lamps : IS:3324/BSEN60400 Ballast for use in fluorescent lighting fittings : IS:1534 (Part1)/BSEN60920&60921

Transistorizedballastforfluorescentlamps : IS:7027

BallastforHPmercuryvapourlamp : IS:6616

Capacitorsforuseinfluorescentlamps BSEN 61048 : IS:1569/

HPMV & LP sodium vapour discharge circuits & 61049 /

IEC:60586 Vitreous enamel reflector for tungsten : IS:8017 filament lamp

Tubularfluorescentlamps : IS:2418(Part –1)/BSEN 60081 IEC:60081

Highpressuremercuryvapourlamps BS:3677 / IEC:60188 : IS:9900/

TungstenfilamentGeneralElectriclamps IEC:60432 : IS:418/

CastacrylicsheetsforuseinLuminaires : IS:7569

Screwlessterminalandelectrical connectionsforlightingfittings : IS:10322

Highpressuresodiumvapourlamps : IS:9974

Emergencylightingunits : IS:9583

Ignition proof enclosures, dust-tight for : IS:11005

elect Equipment

Luminaires : IS:10322(PartItoV)

LightingSystemEquipment

Arrangement for busbars, main connections : IS:5578/11353/ BS:159

andauxiliarywiringand marking

Enclosed distribution fuse boards and : IS:2675/ BSEN 60439

Cut-outsforvoltagesnotexceeding1000V

General requirements for switchgear and : IS:13947

Control gear for voltages not exceeding

1000V

Codeofpractice-installationand : IS:10118/ BS:6423

Maintenanceofswitchgear : BS6626,BS6867

Factory built assemblies of switchgear : IS:8623/ BS-5486 / IEC:60439

andcontrolgearforvoltagesuptoand

Including1000 V AC and 1200 V DC

Miniature air break circuit breakers for : IS:8828/ BSEN 60898

ACcircuits

HRC cartridge fuse links up to 650 V : IS:9224/ BS:88 / IEC:60269

Currenttransformers
:IS:16227(Part2):2016/IEC61869-2:2012

Voltagetransformers
:IS:3156/ BS:7625/ IEC:60186

Direct acting electrical indicating Instruments : IS:1248/BS:89/ IEC:60051

ACelectricitymeters
:IS:722 / BS 5685

Electrical relays for power system protection : IS:3231/BS:142/ IEC:60255

Switches for domestic and similar purposes : IS:3854/BS:3676

Three pin plugs and socket outlets :
IS:1293/ BS:546

Boxesforenclosureofelectrical accessories : IS:5133(1)

Rigidsteelconduitsforelectrical wiring : IS:9537/ BS:31

Accessoriesforrigidsteelconduitsfor BS-31 : IS:3837/ electricalwiring

Flexiblesteelconduitsforelectricalwiring : IS:3480

Rigidnon-metallicconduitsforelectrical BS:4607(2) : IS:9537/ Installations

Fittingsforrigidnon-metallicconduits BS:4607(2) : IS:3419/

PVCinsulatedcablesforworkingvoltages : IS:694

Uptoandincluding1100V

Tubularsteelpoles
: IS:2713

Specificationforcopperrodsandbars : IS:613

Code of practice for phosphate coated iron : IS:6005/

BS:3189

and steel

Fittingsforrigidsteelconduitsfor electricalwiring : 14768:Part2

LightingFixtures(Luminaires-LED)

(f) Luminairesshall bedesigned forcontinuoustrouble-free operation withoutreductioninlamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather- proof and rain-proof type.

(g) The Luminaires shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps / starters etc.

(h) Connections between different components shall be made in such a way that they shall not work loose by small vibration.

(i) For each type of Luminaires, the Contractor shall furnish the utilisation factor tables to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.

(j) All Luminaires shall be supplied complete with lamps suitable for operation on a supply voltagewiththevariationinsupplyvoltage,frequencyandcombinedvoltageandfrequencyof
± 10%,± 5%and± 10% respectively.

DecorativeLuminaires(Luminaires-LED)

(f) These luminaires shall be generally indoor type provided with cold rolled cold annealed(CRCA) sheet steel channel / rail cum reflector housing complete with all electrical control accessories mounted on it. The finish shall be stove enamelled.

(g) Decorative LED type luminaires shall be either open type, provided with translucent white opal acrylic diffusers, polystyrene lens prismatic or square polystyrene louvers

(h) Luminaires shall be suitable for the number of lamps of specified wattage, direct mounting on ceiling / wall / column pendant mounting or for recess mounting in false ceiling.

(i) Decorative luminaires with mirror optic reflectors shall be of the wide-angle dispersion type. Where these luminaires are mounted in control rooms and computer rooms, clip-on type adjustable reflectors which can be attached onto the tube shall be provided to direct the light output in the desired direction. This shall be mainly to reduce reflection of the light source from TV / monitor screens.

(j) Luminaires mounted recessed in false ceiling shall be with reflector housing and spring-loaded fixingarrangement forthediffuser/ louver frame. It shall bepossibleto have accesstothelamp and other accessories from below.

IndustrialLuminaires(Luminaires-LED)

(e) The luminaire shall be provided with CRCA sheet steel mounting rail with reflector ofminimum 20 SWG thicknesses and complete with all control

accessories mounted on it. The finish shall be vitreous enamelled.

(f) Luminaires shall be suitable for the number of lamps of specified wattage, direct mounting on ceiling / wall / column / pendent mounting.

(g) The distribution of light shall be such that at least 80% of the total luminous flux from the luminaire shall be in the lower hemisphere.

(h) The luminous output of the luminaire with reflector shall not be less than 75% irrespective of type of reflector used

BulkheadLED Luminaire

(c) The luminaire shall be of robust construction, with cast aluminium / vitreous enamelled housing, heat and shock resistant prismatic or clear glass cover fixed with neoprene gaskets for sealing. For mechanical protection to the glass cover, round steel wire-guard with vitreous enamelled finish shall be provided

(d) The luminaire shall be suitable for direct mounting to ceiling / wall / column and used for general purpose indoor lighting.

High,MediumandLowBayLEDLuminaires

(d) High and mediumbayluminaires shall be withcast aluminiumhousing, anodizedaluminium mirror polished reflector canopy with eye bolt for suspension, cooling fins and glass cover.

(e) Theluminaireshallbesuitableforupto400/1000wattsLEDlamps.Thecontrolgear accessories shall be mounted integral with the luminaire.

(f) Highbayluminairesshallbeusedwhenthemountingheightisabove8meterswhile medium bay luminaires shall be used when the mounting height is around 6 to 8 meters.

FloodLightLED Luminaire

Floodlightluminairesshallbeofweatherproofconstructionwithcastaluminiumhousing,anodized aluminium mirror polished reflector, heat resistant, toughened glass cover and necessary neoprene gaskets to prevent ingress of dust

(c) Thehousingshallbesupportedonacastironbaseandcapableofbeing swivelled in both horizontal and vertical directions and locked in any desired position.

(d) Forfocusingpurposes,knobs,shallbeprovidedalongwithsectorplateindicating the angle in degrees between 0 and 90 deg in vertical direction.

OutdoorLanternLEDLuminaires

(c) Post top lantern Luminaires shall be generally outdoor weatherproof type for illumination of walkways, gate posts, gardens etc

(d) The luminaire shall have cast aluminium spigot of 50 / 60 diameter finished with corrosion proof paint for mounting, opal acrylic or high-density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.

Sub-stationLantern

(c) Sub-station lantern shall be generally outdoor weatherproof type for illumination of switchyard equipment.

(d) The luminaire shall have cast aluminium housing finished with corrosion proof paint, spigot for mounting on pole, prismatic glass refractor dome to give distribution of light in horizontal plane,anodizedaluminiumreflectortogivelightdistributionatanangle20to40degrees,

abovethehorizontalplane,completewithintegralmountedcontrolgear,neoprenegaskets, earthing terminal etc.

StreetLightingLuminaires

(i) Street lighting LED luminaire shall be outdoor weatherproof type for illumination of secondary roads, walkways, peripheral lighting of buildings etc.

(j) The luminaire shall be of semi-cut off or non-cut off type, with CRCA sheet steel housing, vitreous enamelled, plain or corrugated clear acrylic cover, complete with integral mounted control gear, neoprene gaskets, side pipe entry or top suspension type.

(k) The luminaire shall be of semi-cut off with cast aluminium housing, acrylic or prismatic cover, polished aluminium reflectors, complete with integral mounted control gear, neoprene gaskets and with rear pipe entry.

(l) TheContractor shallprovide street lightingsystems to illuminateall site roadways within the treatment facility areas and access road. Lux level for outdoor site shall be as per IS 1944. Outdoor lighting shall cover the perimeter portion also to focus CCTV camera at 20 Lux level.

(m) Thelanterns shall incorporate LEDlamps with integral lamp control gear, and weather-proof body.

(n) The poles shall be sited a minimum of 1m from the road kerb edge with non-extended brackets to locate the lanterns at the kerb.

(o) The street lighting shall be fed on independent radial buried cable circuits fed and controlled from a street lighting switchboard. The cables laid for outdoor lighting application shall be wire armoured.

(p) Each circuit shall be contactor switched, controlled by an astronomical timer and manual - auto control selector switch. The contactor, time switch and manual control switch for each area shall be incorporated in the LV road lighting distribution switchboard.

PortableEmergencyLightLuminaire

(e) Emergency light of installed luminaire shall be indoor type for providing emergency light during failure of normal AC supply.

(f) The luminaire shall be with CRCA sheet steel enclosure, complete with metalized mirror reflector, leak proof re-chargeable battery rated for two-hour discharge, battery charger,charger-on lamp, push button switches, automatic changeover switch / relay, two meter length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminaire.

(g) The luminaire shall be suitable for connection to 240 V, 50 Hz single phase supply. On failure of normal AC supply the luminaire shall pick-up automatically and on restoration of AC supply the luminaire shall switch off automatically.

(h) Theluminaireshallbesuitableforenergyefficiency LEDlamps.

AccessoriesforLumi

naires Reflectors

(e) The reflectors shall be made of CRCA sheet steel / aluminium / silvered glass / chromium plated sheet copper as indicated for above mentioned luminaires.

(f) The thickness of steel / aluminium shall comply with relevant standards. Reflectors made of steel shall have vitreous enamelled finish. Aluminium used for reflectors shall be anodized / epoxy stove enamelled / mirror polished. The finish for the reflector shall be as indicated for above mentioned fittings.

(g) Reflectors shall be free from scratches or blisters and shall have a smooth and glossy surface having an optimum light reflecting coefficient so as to ensure the overall light output specified by the Contractor.

(h) Reflectorsshall bereadilyremovablefromthehousingforcleaningand maintenancewithout disturbingthe lamps and without theuse of tools. Theyshall be securelyfixedto the housingby means of positive fastening device of captive type.

Lampholders/StarterHolders

(e) Lamp holders shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value.They shall hold the lamps in position under normal condition of shock and vibration met with under normal installation and use.

(f) Lamp holders for the fluorescent lamps shall be of the spring loaded bi-pin rotor type. Live parts of the lamp's holder shall not be exposed during insertion or removal of lamp or after the lamp has been taken out. The lamp holder contacts shall provide adequate pressure on the lamp cap pins when the lamp shall be in working position.

(g) Lamp holders for induction, mercury vapour and sodium vapour lamps shall be of Edison Screw (ES) type.

(h) The starter holders shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.

Controlswitchgearelectronic ballasts

(d) The ballasts shall be designed to have a long service life and low power loss. The ballasts shall be of the inductive, heavy duty type copper wire wound, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. Ballastsshall be provided withtapsto set thevoltage within therange of variationin supplyvoltage of± 10% of 240 V End connections and taps shall be brought out to a suitable terminal blockrigidly fixed to the ballast enclosure. Ballasts shall be free from hum and such of those which produce hum shall be replaced by Contractor free of cost.

(e) Ballasts shall be mounted using self-locking, anti-vibration fixings and shall be easy to remove without demounting the fittings. They shall be in dust tight, non-combustibleenclosures.

(f) Separate ballast for each lamp shall be provided in case of multi lamp luminaires, except in the case of 2 x 20 Watts luminaires.

Starters/ Igniters

(b) Starters shall have bimetal electrodes / electronic igniters and high

mechanical strength. Starters shall bereplaceable without disturbingthereflector or lamps and withoutthe use of any tool Starters shall have brass contacts and radio interference capacitors.

Capacitors

(d) The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

(e) The capacitors shall be suitable for operation at specified supply voltage conditions and shall haveavalueofcapacitancesoastocorrectthepowerfactoroftheircorrespondingl ampscircuit to the extent of 095 lag or better.

(f) The capacitors shall be hermetically sealed preferably in a metal enclosure to preventseepage of impregnate and ingress of moisture.

GalvanizedOctagonalPolesforStreet Lighting

The Octagonal poles shall be designed to withstand the maximum wind speed of 169 KM / Hr. as per IS875.Thetoploadingi.e.,areaandtheweightoffixturesaretobeconsideredtocalculat emaximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI.

(l) PoleShaft

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinalwelding.Thereshallnotbeanycircumferentialwelding.Theweldingofpo leshaftshall be done by submerged Arc Welding (SAW) process.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provisionforfixing4foundationbolts.Thisbaseplateshallbefilletweldedtothepolesh aftattwo locations i.e., from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

(m) Door opening

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from theBaseplate.Thedoorshallbevandal resistanceandshall beweatherprooftoensuresafetyofinside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

Thepoleshallbeadequatelystrengthenedatthelocationofthedoortocompensatefort helossin section.

(n) Material

OctagonalPoles : HTSteelConformingtogradeS355JO

Base Plate :

Fe410conformingtoIS226/IS2062

Foundation Bolts : EN8 grade

(o) Welding

Theweldingshallbecarriedoutconfirmingtoapprovedproceduresdulyqualifiedbythi rdparty inspection agency. The welders shall also be qualified for welding the octagonal shafts.

(p) Polesections

TheOctagonalPolesshallbeinsinglesection(upto11mtr)Thereshallnotbeanycircumferential weld joint.

(q) Galvanization

ThepolesshallbehotdipgalvanizedasperIS2629/IS2633/ IS4759standardswithaverage coating thickness of 100 micron the galvanizing shall be done in single dipping.

(r) Xingtype

TheOctagonalPolesshallbeboltedonapre-castfoundationwithasetoffourfoundationboltsfor greater rigidity.

(s) TopMountings

ThegalvanizedmountingbracketshallbesuppliedalongwiththeOctagonalPolesforInstallationof the luminaries.

(t) Manufacturing

Thepolemanufacturing&galvanizingunitshallbeISO9001:2000&ISO14001certifiedtoensure consistent quality & environmental protection.

(u) Servicewindow

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow accesstoelectricalconnectionsandterminations.ItshallbecoveredwithGIplateandproperrubber gaskets shall be provided to prevent any ingress of water etc.

(v) Electricalconnections

Four-wayconnectors shallbe provided alongwith Slide lockand1 no. 6amps SP MCBincluding2.5 sq.mmPVCinsulatedcopper conductorwiresfromtheterminal blocktothefixtureand2nos.32mm dia. GI sleeves of suitable length shall be provided up to the service window. An earth boss shall be provided on the control plate along with connectors and interrupters.

DrawingsandData

AllDrawings,data,technicalparticulars,calculations,detailedliterature,catalogues,testcertificates etc shall be submitted alongwiththe bid/ after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

LightingSystemEquipment

MainLightingDistributionBoardandLightingPanels(ACPhasesegregated&DC)

(c) ConstructionalFeatures

(viii) Boards and panels shall be sheet steel enclosed and shall be fully dust and vermin proof, providing a degree of protection of IP 52 for indoor. Outdoor panels shall in addition be completely weather-proof with a sloping canopy for protection against rain and providing a degree of protection of IP 55. The sheet steel used for frame, frame enclosures, doors, covers and

partitions shall be cold rolled 2 mm thick.

(ix) All boards and panels shall be provided with hinged doors for access to equipment. Doors shall be gasketed all round with neoprene gaskets. For the main floor mounted distribution boards with the MCB arranged in tier formation, the hinged door of each unit shall be interlocked so as to prevent opening of the door when the switch shall be ON and to prevent closing of the switch with the door not fully closed. However, a device for by-passing the door interlock shall be provided to enable the operation of the switch with the door open, when necessary, for examination / maintenance. For wall mounting 1-phase ways lighting panelswhen provided with MCBs, a hinged, latched front door shall be provided with key-locking facility and a slotted Bakelite sheet shall be provided inside. Only the MCBs operating knobs or the fuse cap covers shall project out of the Bakelite sheet slots for safe operation and neat appearance Incomer to lighting panels shall be provided with TPN MCCB with RCD.

(x) All accessible live connections / metals shall be shrouded, and it shall be possible to change individualfuses,switches,MCBsfromthefrontoftheboards/panelswithoutdangerofcontact with live metal.

(xi) For floor mounting type distribution boards, adequately sized mounting channels shall be supplied and for wall / column / structure mounting type panels suitable mounting straps shallbe provided.

(xii) Adequate interior cabling space and suitable removable cable entry plates shall be provided for top / bottom entry of cables through glands and or conduits as required. Necessary numberof glands to suit the specified cable sizes shall be provided. Cable glands shall be screwed on type and made of brass.

(xiii) Twoearthingterminalsshallbeprovidedtosuittheearthingconductor

(xiv) All sheet steel parts shall undergo rust-proofing process which should include degreasing,de-scaling and a recognized phosphate process. The steel works shall then be painted with two coats of Zinc - chromate primer and two coats of final stove-enamelled finish paint of specified colour.

(d) Busbars

(vii) Busbarsshall beofcopperconductorofharddrawn(HD)andhighconductivity. All busbars shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi.

(viii) Busbars shall be provided with at least the minimum clearances in air as per applicable standards for 500 V, 3 phase system.

(ix) Busbars shall be adequately sized for the continuous current rating such that the maximum temperature of the busbars, busbar risers / droppers and contacts does not exceed 85° C under site reference ambient temperature.

(x) The busbars, busbar connections and busbar support shall have sufficient strength to withstand thermal and electro-mechanical stresses of the fuse / MCB’s let through / cut-off current associated with the specified short-circuit level of the system.

(xi) Busbar supports shall be made from suitable insulating material such as Hylam sheets, glass reinforced moulded plastic materials, permali wood or cast resin. Separate supports shall be provided for each phase of the

busbars. If a common support shall be provided for all three phases, anti-tracking barriers shall be incorporated.

(xii) The neutral bus of the main 3 phase, 4 wire distribution board shall be rated not less than50%ofthephasebusbars.Theneutralbusofthe1phasewayslightingpanelshallberated

sameasthephasebusbars.Theneutral busshouldhavesufficientterminalsanddetachablelinks for full number of single-phase outgoing lighting circuits.

Panels/Boards'ComponentEquipment

(g) MiniatureCircuitBreakers(MCB)/RCD

(v) MCBs shall be hand operated, air break, quick make, quick break type conforming to applicable standards

(vi) The switch shall be protected by fuse and the MCB shall be provided with overload / short- circuit protective device for protection under overload and short-circuit conditions. The minimum breaking capacity of MCBs shall be 10kA rms at 415V / 220V DC.

(vii) Switch shall have provision for locking in both fully open and closed positions. MCBs shall be provided with locking facility

(viii) The incomer shall be MCCB for ≥ 63A and shall be MCB TPN for < 63A connections shall be phase segregated shall be insulated and all live connections shall be shrouded RCD with suitable rating shall be provided for incomer 100mA and power receptacle feeder 30mA One digital type energy meter shall be provided on each lighting MCB DB.

(h) Fusesfor DC

(i) Fuse less system shall be preferable however some special case fuses can be used. Fuses generally shall be of the HRC cartridge fuse-link type having a certified rupturing capacity of 80kA at 440V. Fuses up to 63A for distribution systems of medium short circuit levels may be of HRC linktype, having a certified rupturingcapacityof not less than 46kA at 440V and 16kA at 250V DC.

(v) Fusesshallbeprovidedwithvisibleindicationtoshowthattheyhave operated.

(vi) Insulatedfusepullinghandleshallbeprovidedforeachsizeoffuseforeachswitchboard.

(i) IndicatingInstrumentsandMeters(Digital)

(iv) Whenever required, digital instruments and meters shall be of the flush mounting type They shall be suitably mounted so as to provide for easy access to CTs and small wiring.

(v) Instrumentssuchasvoltmeterandammetershallbeofdigitalinstruments.

(vi) Watt-hourmetersshallbeofdirectreadingofdigitalmultifunctionmeter.

(j) InstrumentTransformers

(iv) Current and voltage transformers shall be of the dry type, of metering accuracy class 1.0 unless otherwise specified, it shall be the responsibility of the Contractor to ensure that the VA burden of the instrument transformer shall be adequate for the meters connected to it.

(v) Testlinksshall beprovidedinbothsecondaryleadsof theCTstoeasilycarryoutcurrentand phase angle measurement tests. Facilities shall be provided for short-circuiting and grounding the CTs at the terminal blocks.

(vi) Voltagetransformersshallbeprovidedwithsuitablyratedprimaryandsecondaryfuses.

(k) Indicating Lights: Indicating lights shall be of the clustered LED type with translucentcovers.

(l) InternalWiring.

(vii) Panels / boards shall be supplied completely wired, ready for the external connections at the terminal blocks. Wiring shall be carried out with 650 / 1100V grade, PVC insulated, stranded copper conductors of adequate sizes shall be used to suit the rated circuit current.

(viii) Engraved identification ferrules marked to correspondwith the wiringdiagramshall be fitted at both ends of each wire.

(ix) All wiring shall be terminated on terminal blocks. Terminal blocks shall be one piece moulded rated 500 V of reputed make, preferably stud type for higher current ratings such that wires are connected by cable-lugs and complete with nuts and washers. Terminals shall be adequately rated for the circuit current; the minimum rating shall be 20A.

(x) Terminalsforcircuitswithvoltageexceeding125Vshallbeshrouded.

(xi) Terminals shall be numbered and provided with identification strip for identification of the circuit.

(xii) Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting / earthing facilities.

Labels&Diagram Plate

(d) All door mounted equipment as well as equipment mounted inside the switchboard / panels shall be provided with individual labels with equipment designation / rating. Also, the boards / panels shall be provided on the front with a label engraved with the designation of the board / panel.

(e) Labelsshallbemadeofnon-rustingmetal,3-plylamicoidorengravedPVC.

(f) Inside the door of the 1 phase ways lighting panels a circuit diagram / description shall be fixed for reference and identification.

LightControlboxand switches

(d) Light control switches of ratings and types, i.e., decorative / industrial shall be supplied as required. The switches shall be Modular suitable for use on 240V, 1Ph, 50Hz supply.

(e) Switches shall be of flush type for mounting behind an insulated modular plate or incorporated with a switch plate for mounting flush with the surface of wall or switch box / suitable enclosure. The modular switch box / enclosure may be recessed into or mounted on a wall as per the requirement of project layouts.

(f) Thesizeofenclosuremodularboxesshallbechosentoaccommodatethenumberofswitches to be installed at the particular location. The enclosures shall be 18-gauge sheet steelgalvanized. The enclosure plates / boxes shall be fabricated out of quality tested raw material such as metal, PVC, power coated metal. An enclosure intended for surface mounting shall not have holes or gaps in its sides other than those expressly provided for cable entry.

ReceptacleUnits

(f) Receptacle units shall consist of socket outlet with associated switch and plug. The socket outlet and switch (5/6A) or MCB (15/16A) shall be flush mounted within galvanized 18-gauge steel / modular enclosure with

insulation cover. The box may be recessed into or mounted on a wall as per requirements of project layouts.

(g) The receptacle units shall be suitable for 240V, 1ph - N, 50Hz, 5 / 6A / 415V, 3Ph – N,50Hz, 15 / 16A supply as required.

(h) Single phase receptacles 15 / 16A shall be associated with ELCB and MCB of same current rating and the receptacle shall become live only when the associated ELCB and MCB shall bein “ON” position.

(i) Three phase receptacles shall be metal clad associated with a TPN MCB housed in the same enclosure. The receptacle shall become live only when the associated MCB switch shall be in “ON” position.

(j) The plugs shall be provided along with three phase receptacle with cord grips to prevent strain and damage to conductors / wires at connection and entry points.

LightingWires

(d) Thewiresforwiringinlightingsystemshallbe1100-voltgradeISImake,1C,PVCinsulated, un-armoured with stranded copper conductors.

(e) The minimum area of conductors shall be 15 sq.mm for light fittings and 5/6A Receptacles and 25 sq.mm for receptacles rated 15 / 16 A and above.

(f) The wires shall be coded white for phase/positive of DC and black for neutral / negative of DC.

Conduits

(d) Rigid non-metallic conduits and their associated fittings as required shall conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm for concealed installation.

(e) Non-metallic conduits shall be supplied in standard lengths of 5 m of 25 mm thickness and shall conform to IS 9537: Part 3.

(f) Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting system installation work inclusive of all the consumables such as adhesive tape / paste, rawal plug, screws etc.

JunctionBoxes

(f) Square or rectangular type modular Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for indoor / outdoor areas, 3 phase receptacles etc.

(g) Thejunction boxes shall be dust and vermin proof and shall be fabricated fromquality tested raw material such as metal, PVC and powder coated metal and shall be complete withremovable cover plate with gaskets. Boxes shall be additionally weatherproof with earthing terminals.

(h) The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable / conduit entry knock outs, terminal blocks, earthing terminals as required.

(i) The terminal blocks, with specified number of terminals, shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 600 V, grade, one piece construction complete with terminals, insulation barriers, galvanized nuts, bolts and washersand provided with identification strips of PVC The terminals shall be made of copper alloy and shall be of box clamp type.

(j) Theboxes shall be aesthetic lookand weatherprooffor outdoor unit with MCBfor branching lighting circuit.

DrawingsandData

AllDrawings,data,technicalparticulars,calculations,detailed literature,catalogues,testcertificates etc shall be submitted alongwith the bid / after award of contract as specified under “Bid / Contract Drawings”, Part 3, General Requirements, Volume - 2 of Bid Documents.

RenewableEnergy Capability

SolarPVRooftopsystemforstreetlightingonly

- The available shadow free roof top area shall be utilized to harness the solar energy. This shall provide a clean and renewable source of energy. The system shall comprise of PV Module(Thin film, poly crystalline), Power Conditioning Unit, and Solar Inverter with necessary accessories. The components shall be as per MNRE approved makes. The solar roof top system shall be grid connected based on Net Metering Regulation of KERC as amended up to date.
- The PV modules used shall of ≥ 250Wp ratings as per MNRE or KERC guidelines, the stricter one to be followed. The PV modules shall be poly-crystalline, thin film with efficiency assurance of 15%. The installation shall have proper space provision such that maintenanceshall be easy as the same shall ensure non reduction in PV panel efficiency.
- The street lighting shall be fed on independent radial buried cable circuits fed and controlled from a street lighting switchboard. The cables laid for outdoor lighting application shall be wire armoured.
- Each circuit shall be contactor switched, controlled by an astronomical timer and manual- auto controlselectorswitch.Thecontactor,timeswitchandmanualcontrolswitchforeachareashall be incorporated in the LV road lighting distribution switchboard.
- Street lighting shall be Centralized, off grid solar power supply system suitable for powersupply to required number of streetlights to illuminate the complete treatment facility.Necessary interlocks shall be provided between main supply and solar supplyin such way that solar energy shall be used always and switchover to EB source automatically, when there shall be no solar energy available.

TheCentralizedsolarlightingsystemsshallcomprise:

(vi) Solar modules.
(vii) Batteries(for12Hrbackup,SMFleadacidtype).
(viii) Inverter.
(ix) Cables.
(x) Required protection and control devices (Short circuit, reverse polarity, battery over charging, deep discharging etc) and wiring work.

Solar module shall convert solar energy into electrical energy and store into the battery. During the night-

timestoredenergyshallbeconvertedtoACusingefficientinverterandshallbesupplie dtothe streetlights. The system shall be powered from the normal grid supply in case of cloudy days or in case of insufficient day light to charge the battery. Roof of “**AIR BLOWER BUILDING”** of STP area can be used for solar cell.

EarthingandLightingProtectionSystem

General

Theearthingandlightningprotectionsystemcoversearthingconductors,earthelectrodesand accessories.

- Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system.
- Cranerails,tracks,metalpipesandconduitsalsoshallbeearthedattwopoints.
- Steel RCC Columns, metallic stairs and rails of the building housing electrical equipment also shall be connected to nearby earthing grid conductor.
- Metallicsheaths/ screensandarmourofmulticorecablesshallbeearthedatbothends.
- Metallicsheathsandarmourofsinglecorecablesshallbeearthedattheswitchgeared only.
- Every alternate post of switchyard fence shall be connected to the earth grid by GS flat and gates by flexible lead to earthed post.
- Each Continuous laid length of cable trayshall be earthed at minimumtwo placesbyGS Flats to earthing system; the distance between the earthing points shall not exceed 20m.
- Lightning Protection System shall compromise vertical / horizontal air termination rod/strip, airterminationsupportsystem,downconductors,downconductorholders,test links,counters, and earth electrodes with chambers. Air terminations, down conductors and test links shall be of galvanized steel conductors and earth connection below the ground level shall be of mild steel. Lightning Protection System down conductors shall not be connected to other earthing conductors above the ground level.

ApplicableStandards

TheearthingandlightningprotectionsystemshallconformtotheNationalElectricalCode,National Building Code, CEA Regulations, and the latest applicable standards indicated below:

CodeofPracticefor Earthing : IS:3043-2018

ManualonEarthingofACPowerSystem : CBIP 302

CodeofPracticefortheProtectionof :
IS/IEC:62305-1to4

Buildingandalliedstructureagainst lightning

Hotdip galvanizing :
IS:2629,2633,4759

Structuralsteel :
IS:2062&808

Welding :
IS:816

EarthingSystem

The electrical installation shall be required to be connected to the general mass of theearth by an earthing conductor. The material used for the earthing conductor shall be as follows:

(f) Conductorsabove groundlevelandintrenches: galvanisedsteelflat
(g) Conductorburiedinthe groundor embeddedinconcrete:mildsteel flat.
(h) PipeElectrode:Cast IronorGalvanized Iron
(i) RodElectrodes:MildSteel
(j) Lightningprotectionairterminationanddownconductorsforbuildings:galvanized steel

Allowance shall be made for reduction in the cross section of the steel over the design life of the earthing system.

Conductor sizes for burial in earth shall be calculated with indicated corrosion allowances as per IS 3043-2018. The minimum thickness shall be considered as 6mm.

The earth electrode system shall comprise one or more earth electrodes, earthing network, mesh or a combination of these in order to obtain the required earth electrode resistance.

Earthelectrodes whereused shall beofheavy-dutyGIpipeofnot less than40mm NBand 4150mm long. Where multiple electrodes are used, they shall be separated by a distanceof not less than the driven length.

Each earth electrode pipe shall be welded at the top to a mild steel plate to which the earthing tapes shall be connected. These connections shall each be housed in individual concrete inspection chamber set flush to the finished ground level and shall allow disconnection for testing of individual electrodes. The chamber shall be permanently marked ‘Electrical Earth’.

All materials used for the earth electrode installation shall be purpose made for the application and site conditions and shall be approved by the Employer’s Representative.

Unless otherwise stated all excavation for the installation of the earth electrodes and the inspection pit shall be carried out by the Contractor.

After the earth installation has been completed, the Contractor shall demonstrate to the Employer’s Representative that the resistance of the electrodes to earth and the continuity of the earth network are within the limits specified. Any additional earth electrodes and test instruments required for the tests shall be provided by the Contractor.

Marker posts and plates shall be provided to mark the route of buried tape or conductor electrodes. The markers shall be similar to those provided for cable routes.

Two earthing leads shall be used for voltage of the equipment above 250V and for rated voltage of 250V and below, one earth lead shall be provided.

Earth conductors laid in soil in the form of closed grid for the main plant area which covers transformer yard, substation building and all other individual buildings.

Transformer & DG neutrals. Lightning arrestors, capacitor banks, surge arrestors, 24 DC system, UPS, each downcomer of lightning protection system shall be directly connected to independent earth electrodes. Earth leads of DG & transformer shall be connected to TWO separate treated earth pits by TWO separate earth leads starting from neutral bushing. Any specific requirement of local authority regarding type of electrode shall be met with.

Main earthing conductors shall be buried in earth around each building at a minimum depth of 600mm at a distance of 1500mm from outer boundary of the building.

The earth grid of different areas shall be interconnected through test pits to the main plant area earth grid to enable measurement of ground resistance of each area separately.

Minimum two tap offs from main earthing loop outside the building shall be taken inside the building and connected to the earthing conductor embedded in floor slab with approximately 50mm cover or to the earthing conductor in cable trench.

Tap off from the main earth grid shall be taken with earth riser of 500mm length above ground level for outdoor and 200mm length for risers inside the building.

Separatefloorearthgridsshallbeformedandinterconnected formulti-storeybuildings.

LightningProtectionSystem

(x) The need of lightning protection has been established by calculating the overall riskfactor as per IS / IEC 62305 series.

(xi) Air termination system comprising of rods/mesh or combination of both shall beprovided and the methods used to determine the positioning of Air termination system shall be as per IS/IEC 62305.

(xii) Air termination system shall be connected to the earthing system by down conductors fixed along the outer surface of building Number & layout of the down conductors shall be as per IS / IEC 62305.

(xiii) Each down comer shall be terminated to a separate treated test earth electrode which in turnshall be connected to station earthing system.

(xiv) The link shall be provided in the run of each down conductor at approximately 1000 mm above ground level.

(xv) Thelightningprotection airterminationnetworkshallbe fixedinsucha waythat theyremainin their installed position even during severe weather conditions. The necessary accessories suchas cleats, clamps, welding materials, bolts, nuts shall be provided.

(xvi) Airterminationsystemshallbeconnectedtotheearthingsystembelow groundbydown conductors.

(xvii) Alljointsin thedown conductorsshallbeofwelded /brazed type.

(xviii) Thelightning protectionsystemshallnotbeindirectcontactwithunderground metallic service ducts, cables, cable conduits and metallic enclosures of electrical equipment.

MainEquipotentialBondingConductor

Mainequipotentialbonding conductors shallbe provided toconnectthe earth electrode system to conductive parts forming the works.

Equipotentialbondingconductorsshallhavethefollowing**minimumsizes**aspe rCl.No.
6.17.3 & 6.17.4. Actual equipotential bonding conductor size shall be calculated based on the fault conditions.

(d) <u>MainEquipotential Conductors</u>

- MainEarth Conductorburied in earth 65 x 10 mmMS flat
- MainEarth Conductoraboveground 65 x 10 mmGS flat
- Transformers,main switchboard 65x 10 mm GS flat andstandbygeneratorinstallation

- APFCPanel
  65 x10 mm GS flat
- interconnection to lightning protection system 50x10mmGS flat
- interconnectiontoMCCs
  50x10 mm/50x6 mmGS flat

(e) Equipotential Conductors

- interconnectiontoCPs
  25 x3 mm GS flat
- localpushbuttons
  14 SWG GSwire
- lightingdistributionboard
  4 SWG GS wire
- lightingandreceptacles
  ystem 12 SWG GS
  wire
- outdoorstreetlighting
  8 SWG GS wire
- ladder rack and cable tray at suitable points 25 x 3 mm GS flat
- handrailsandmetallicstru
  ctures 25 x 3 mm
  GS flat
- building reinforcement
  25 x3 mm GS flat
- incoming and outgoing process services 25x3mm GS flat
- steel structures comprising storage tanks, 25x3mm GS flat
  mezzanineplatform,cranerails,airh
  andling ductwork systems etc.

(f) LVMotors

- up to 10 kW
  8 SWG GS wire
- 10 to 20 kW
  4 SWG GS wire
- 20 to 50 kW
  25 x3 mm GS flat
- Above50 kW

50 x10 mm GS flat

- Earth electrode 40mmdia.4150 mmlongheavy Duty GI pipe electrode as per IS 3043- 2018

Notes:

3. Equipotential conductors shall interconnect between the device to be bonded and the main equipotential conductor.
4. Connections to building structural steelworkor concrete reinforcement shall bemade by a bolted connection to a tag welded to the steelwork or reinforcement bars. Unless otherwise specified at least two connections shall be made to the steelwork and reinforcement bars at the perimeter of each building at diagonally opposite locations.

CircuitProtectiveConductors

Anindependentcircuitprotectiveconductorshallbeprovidedforeachcircuitandmaycomprise one

or anyofthefollowingasappropriate:

- aseparate corewithin a multicore cable.
- a separate conductor installed within a conduit or trunking Steel conduit or trunking shall not be used as a circuit protective conductor.
- themetal sheath of an armoured cablethe sheath shall bebonded to themetalwork of the apparatus and to the apparatus earth bar if any.
- thecoppersheathofamineralinsulatedcoppersheathed cable.
- an independent earthing conductor MS or GS conductor run adjacent to the circuit it protects.

Circuit protective conductors associated with the main circuits supplying switchboardsand large electrical loads, i.e., motors in excess of 75 kW shall form a separate core of a multicore cable feeding the device or shall be an independent insulated copper conductor run adjacent to the supply cable. The size of the circuit protective conductor shall be calculated in such a manner as not to take into consideration the contribution of any other parallel or fortuitous earth paths.

Thearmouringofthesupplycableshallnotform thesolemeansofearthingaswitchboard or large electrical load.

Where the cable armouring or sheath shall be used as the circuit protective conductor it shall be securely bonded at both ends to the metalwork of the apparatus and to an earth bar. Particular care shall

be taken to ensure continuity across items of apparatus situated within a cable run and should the design of such items of apparatus not give adequate and lastingcontinuitythroughitsstructuralbodythenadditionalearthingclipsa ndconductors

shall be provided to independently bond the cable sheaths together. Similarly additional earthing clips shall be provided to bond the cable sheaths / armour to any piece of apparatus fitted with a special earth terminal should the earth connection for the termination gland be inadequate. Any additional earthing clips shall be fitted within the apparatus wherever possible.

InstrumentationEarth

An instrumentation earth bus, if required shall be provided in each control panel. Thisshall comprise a copper flat of cross section not less than 25 x 6 mm and length to suit the number of connections. It shall be mounted on at least two insulated supports and be provided with a single earth connection to the instrument plate type earth. If due to the physical size of a control panel more than one instrument earth bar shall be required, the additional bar shall be connected again with a single earth connection to the same point as before. In this fashion all instrument earths shall be connected radials from the same plate type earth point.

The earth pit for instrumentation system shall be separate. Electric earth pit shall not be used for earthing of instrumentation equipment. All signal cable screens (analogue and digital) shall be terminated onto the instrument earth bar. Signal cable screens shall be earthed at the control panel end only. Screens at the field end shall be tied back and insulated. Connection between instrument earth bar and instrument plate type earth pit shall be insulated copper wire such that earth pit resistance shall be less than 1 Ohm at panel.

SPD s associated with the control and instrumentation system shall be earthed to the instrument earth in accordance with the SPD manufacturer’s recommendations.

Galvanising

Wherever galvanising has been specified, the hot dip process shall be used. Thegalvanised coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated below:

c) FabricatedSteel

Thicknesslessthan 2mm, Butnotless than12 mm	340gms/ sqm
Thicknesslessthan5mm,butnotlessthan2mm	460gms/

Thickness 5 mm and over	sqm 610gms/sq m

d) Fasteners

Up to nominal sizeM10	270gms/ sqm
OverM10	300gms/sq m

Burrsshallberemovedbeforegalvanising.Anysitemodificationofgalvanised parts should be covered well by zinc rich primer and aluminium paint.

Insulating Mat

Insulatingmatsshallconformto IS15652/IEC61111.TheSuppliershallbemadefromthematerial Elastomer and free from any insertions leading to deterioration of insulating properties for floor covering in front or the MV and LV switchgear along its length.

Mats shall be free from fabric insertions and fibrous material and resistant to acid, oil & low temperature. Mats shall be solid and no perforated. The upper surface shall have small aberration (roughsurfacewithoutedge)toavoidslippereffectswhilethelowersurfaceshallbeplaneorcouldbe finished slip resistant without affecting adversely the dielectric property of the mat.

Thematsshallhaveclass-Dwithminimumthicknessof3.5mmwithoutnegative tolerance.

Matsofbothtypesshall haveaminimumwidthof900mm.Matsshall besatisfactorilyvulcanized, free from blisters, pinholes, cracks, embedded foreign matter and other physical defects.

Minimum insulation resistance for the mats with tap water (i.e., wet condition) will be of 1,00,000MΩ,whenmeasuredwith5000VMeggeror10,00,000MΩ,whenmeasuredwith500V Megger.

InsulatingmatsshallbemarkedwithstandardmarksandBureauofIndianStandards number.

PreferredMakes/ Manufacturers

ListofpreferredmakesforElectricalEquipment/Items

SL. NO.	DESCRIPTION	VENDOR/ MANUFACTURER / MAKE

1	Distribution Transformers	M/ sCromptonGreavesLimited M/S Volt Amp M/SBharat Bijlee M/sKirloskar ElectricCo.Ltd.

2	11kVMetalenclosed switchboards	M/ sSiemens M/s ABB M/s BHEL M/sSchneider Electric
3	DigitalProtectiveRelays / meters	M/s ABB M/ sSchneiderElectric M/s L&T M/s GE M/s Siemens M/s Mitsubishi Electric
4	CurrentTransformers-LT	M/s AE M/s ECS M/sPrag ati M/s Kappa
5	VoltageTransformers- LT	M/s AE M/s ECS M/sPrag ati M/s Kappa
6	LVSwitchgears&Controlgea rs (PCC’s / MCC’s / PDB’s)	M/ sSchneiderElectric M/s ABB M/ sSiemens M/s GE M/sL&T M/s Mitsubishi Electric Note:Authorizedlicensepart ners/ System Integrators of above manufacturer’s shall

		be TTP certified for IEC 61439

7	LTPowerCapacitors/Panel	M/s ABB M/ sCGPowerSystems M/s Universal M/ sMadhav M/s BHEL M/sL&T M/s Mitsubishi Electric Note:Authorizedlicensepartners/ System Integrators of above manufacturer's shall be TTP certified for IEC 61439
8	DieselEngines	M/s Cummins M/s Caterpillar M/ sKirloskarOilEngines M/s Perkins M/s Crompton Greaves
9	AlternatorsforDGSets	M/ sKirloskarElectric M/s CGL M/sBHEL M/s JyotiM/sSt amford M/sLeroy-Somer
10	VariableFrequencyDrives/ Soft Starters	M/ sSiemens M/s ABB M/s GE

		M/s Schneider Electric M/sMitsubishiElec tric M/s Yaskawa Note:Authorizedlicensepartners/ System Integrators of above manufacturer’s shall be TTP certified for IEC 61439

11	Batteries	M/ sExideIndustries M/s AMCO M/sHBL-NIFE M/sAmararaja
12	BatteryChargers	M/ sUniversalInstruments M/s Amara raja M/sChabbi Electricals M/sHBL-NIFE
13	LightingFixturesand Accessories	M/ sPhilips M/s ABB M/ sCromptonGreavesLimited M/s Wipro M/sBajajElectricals M/sLegrand
14	LTBusDucts	M/s Star Drive M/sPowerGea r M/sC &S ElectricLimited
15	PowerCablesandWires	M/ sUniversalCables M/s Polycab M/ sHavells M/s Finolex M/s NICCO M/s Delton M/sC &S ElectricLimited
16	MLDB’s,LDB’s,SDB’s,MCB’s, RCCB’s	M/s

		Havells M/sStand ard M/s Legrand M/s L & T M/s Siemens M/sSchneider Electric

17	Switches,Plugs,Sockets, Pushbuttons	M/ sLegrand M/s Havells M/s Anchor M/s Cona M/sC &S ElectricLimited
18	CeilingFans	M/s Havells M/sCrompt on M/s Orient M/s Bajaj M/s Usha
19	CableterminationKits	M/s Raychem M/sMahindr a M/s REPL M/s 3M

Note:

All products shall be completely manufactured in the country of Origin as indicated. Assembled products shall not be accepted.

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

Note-2: In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:

(ix) Copies of Type Test Certificate (testing done as per latest standards) not older than 5 years for the items offered.

(x) Demonstrate that the proposed makes are “equivalent” to the approved makes. The contractor shall ensure that alternate makes proposed, shall comply completely to the tender specifications, before the same is submitted

for approval.

(xi) SubmitISOcertificatesfortheOEM.

(xii) Submitqualitycertificatesthattheequipmentadheresto,asrequiredunderthiscontract.

(xiii) Submit product brochures for the proposed equipment, with information on spares availability and service setup in employer’s country.

(xiv) Manufacturerinvolvedinmanufactureofspecifiedproposedequipmentforatleast10years before bid date.

(xv) End user performance certificates for minimum 10 successful individual installations of similar size as per this contract withthe proposed equipment and model no, commissioned inlast 5 years before bid date and satisfactorily operating for at least five years before bid date. Contractor to submit end user reference certificates for each of the installations referenced.

(xvi) Manufacturertoprovidefullcontactinformationforeachreferenceaspartofsubmission.

EndofPart-6

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PART7

GENERAL REQUIREMENTS –

INSTRUMENTATIONCONTROLANDAUTOMATION

Introduction

Thispart coversthegeneralrequirementsforthedesign,supply,installation, inspectionandtestingof theinstrumentation,ControlandAutomation(PLCbasedHMIsysteminclusiveofwire dandwireless communication system) and associated plant and materials.

ReferenceStandards

Unless otherwise approved, instrumentation shall comply with relevant quality standards test proceduresandcodesofpracticecollectivelyreferredtoasReferenceStandardsinclu dingthoselisted below in accordance with the requirements detailed elsewhere in this specification.

BS89-2:1990,EN60051-2:1989,IEC60051-2:1984	Directactingindicatinganalogueelectricalmeasuring Instrumentsandtheiraccessories.
BS1042 (Various)	Measurementoffluidflowinclosedconduits.
BS1646-1:1979,ISO 3511/I-1977	Symbolicrepresentationforprocessmeasurementcontrol Functionsandinstrumentation.Basicrequirements
BSEN837-1:1998	Pressuregauges.Bourdontubepressuregauges. Dimensions,metrology,requirementsandtesting
BSEN60751:1996,IEC 60751:1983	Industrialplatinumresistancethermometersensors
BS3680 (Various)	Measurementofliquidflowinopenchannels.
BS3693:1992	Recommendationsfordesignofscalesandindexeson

analogueindicatinginstruments

BSEN60770-1:1999,IEC 60770-1:1999	Transmittersforuseinindustrial-processcontrolsystems. Methodsforperformanceevaluation
BS4675-2:1978,ISO2954-1975	Mechanicalvibrationinrotatingmachinery.Requirements forinstrumentsformeasuringvibrationseverity
BSEN60584-1:1996,IEC 60584-1:1995	Thermocouplesreferencetables
BS5308 (Various)	Instrumentationcables
BSEN 60529:1992	Specificationfordegreesofprotectionprovidedby enclosures(IPcode)
BSISO11631:1998	Measurementoffluidflow.Methodsofspecifying flowmeterperformance
BS5863-1:1984,IEC60381-1:1982	Analoguesignalsforprocesscontrolsystems.Specification fordirectcurrent signals
BS5863-2:1980,IEC60381-2:1978	Analoguesignalsforprocesscontrolsystems.Specification fordirectvoltagesignals
BSEN60654-1:1993,IEC 60654-1:1993	Industrial-processmeasurementandcontrolequipment. Operatingconditions.Climaticconditions
BS6739:1986	Codeofpracticeforinstrumentationinprocesscontrol systems:installationdesignandpractice
BSEN 60073:2002	Basic and safety principles for man-machine interface, markingandidentification.Codingprinciplesforindicators and actuators
BS1553 (Various)	Specificationforgraphicalsymbolsforgeneralengineering
ISA-5.1-1984-(R1992)	InstrumentationSymbolsandIdentification
ISA-5.4-1991	InstrumentLoopDiagrams

ANSI/ISA-18.1-1979 - (R1992)	AnnunciatorSequencesandSpecifications
ISA-26-1968	DynamicResponseTestingofProcessControl Instrumentation
ISA-37.1-1975-(R1982)	ElectricalTransducerNomenclatureandTerminology
ISA-37.3-1982-(R1995)	SpecificationsandTestsforStrainGage Pressure Transducers
ANSI/ISA-50.00.01-1975 (R2002)	CompatibilityofAnalogSignalsforElectronicIndustrial ProcessInstruments
ANSI/ISA-51.1-1979-(R1993)	ProcessInstrumentationTerminology
ISO9000and 09004	QualitySystems
IEEE60587	PowerSupplySurge Protection
IEC61131-3	ProgrammingLanguagesforProgrammableControllers.
IEC61158-2	CommunicationProtocols
ISO9075(BS6964)	StructuredQueryLanguage (SQL)
BS5515	DocumentationofComputerBasedSystems
BS7165	RecommendationforAchievementofQualityinSoftware
BSEN 50081	ElectromagneticCompatibility
ISO 3511	Processmeasurementcontrolfunctions-instrumentation symbolic representation.
ISO-OSI	7LayerCommunicationModel
IEC-8705101	ModbusProtocolConversion
IEEE472-1974	Surge protection.
NEMA	NationalElectricalManufacturersAssociation

StatementofCompliance

TheContractorshallprovidealistofthereferencestandardsusedandshallprovideacompliance/non- compliance statement during FDS submission once the contract has been awarded.

AllstandardswhichtheContractorintendstousebutwhicharenotpartoftheabove Standardsor otherlistedReferenceStandards,shallbesubmittedtotheEngineerforconsent beforeanydesign against that standard proceeds.

QualificationCriteriaforInstrumentationManufacturer,AutomationSystem Manufacturer, and Automation System Integrator

ISO9001oraboveaccreditationshallbeaminimumqualificationforallInstrumentation and/or AutomationSystemManufacturersandallAutomationSystemIntegrators(SystemIntegrators).

The complete Instrumentation, Control, and Automation works in this contract shall be executed by a singleSystemIntegrator withaminimumof5yearsofexperienceinautomationprojects.TheSystem Integrator shall demonstrate capability and resources for integrating/interfacing control systems from different manufacturers as well as coordination with multiple agencies for contract execution.

The System Integrator shall submit evidence that they employ in excess of 25 personnel, including no less than 15 technical staff to include engineers, programmers, and field technicians. Qualifications and license details for a minimum of three professional engineers in the direct employ of the System Integrator,aswellasresumesofallpersonnelassignedtothiscontractshallbesubmitteddaspartofthe Contractor’s technical bid.

The System Integrator shall be an authorized system integrator for the Automation System Manufacturer(s). Verification certificates shall be submitted directly from the manufacturer(s) of the Automation System. In addition, references shall be provided with the Contractor’s technical bid for a minimum of five (5) locations where the proposed manufacturer’s Automation System has been successfully installed by the proposed System Integrator within five (5) years prior to the bid date and hasbeensuccessfullyoperatingforatleast two(2)yearsimmediatelypriortothebiddate.References shall include name, address, and telephone number for the appropriate contact person.

TheInstrumentationManufacturer(s)shallhaveminimum15yearsofexperienceinIndiainthefield of instrument supply and service and shall have a local service

centre in Bangalore.

All hardware and software proposed shall have been successfully used in a similar sewage treatment plantapplicationforaperiodofatleastfive(5)yearsandbefromestablishedandreputablesuppliers.

DocumentstobesubmitteddduringBidSubmission

1. Include a completeTable of Conformance to eachandeveryreference standards or part of the specifications. Use a chart format with specification part identified, indicate whether eachpart isincompliance,a deviation oranexceptiontothespecificpart.If an exception or deviation, include a narrative description as to how the deviation or exception can benefit the end-user of the system over that item specified.

2. Provide a block diagram of the proposed system showing all major components and their interconnections and interrelationships. Label each diagram and indicate all externalpower and communications interfaces.

3. Provide a written overview of the proposed HMI system, instrumentation system describing the principal functions and capabilities of the system's PC, PLC's, system communications and general system capabilities (maximum number of network nodes, PLC's and I/O points, communication protocols available, etc.).

4. Provideanequipment list withdescriptive literaturefor theproposedsystem.Included on the list shall be all major hardware items. List shall include as a minimum, the manufacturer,thequantityprovided,andmodelnumbersforeach.Technica lschedulesfor Instruments, PLC & HMI shall be duly filled in with relevant details.

5. Provide an operating system and software applications list with descriptive literature for theproposedsystem.Includeall major softwareitems,supplier name,quantity,andmodel numbers. Indicate whether any proposed software is proprietary and would not be turned over to the owner. (No proprietary software shall be accepted).

6. Informationisrequiredfor:

    a. NameandversionoftheproposedPC'soperatingsystem.

b. Nameandversionoftheproposedcomputeroperatorgraphicalu serinterface software package (HMI).

c. NameandversionofthePLCon-line/off-lineprogrammingsoftwareforall controllers

d. Nameandversionofanyrequiredcommunicationsoftware,firmware, etc.

e. Nameandversionofthespecifiedreportapplicationsoftware.

f. Nameandversionofthespecifiedmaintenanceapplicationsoftwareif any.

g. Describehowsystemdatapointsarelinkedfromthesystemdatabasei ntovarious applications such as reporting or maintenance.If via DDE (Dynamic Data Exchange) describe specifically the steps required to import data automatically and on-line into the proposed software applications.

h. Brieflydescribe the required procedure for configuration and/or programmingof the proposed system to add a simple remote PLC and additional I/O's to the system in the future. Describe in detail, specifically how communications are programmedforthefutureremotePLCandthenecessarychangesre quiredatthe main controller.

i. Provideadescriptionofanynon-residentsoftwarerequiredtoprogram, troubleshoot or diagnose any devices in the system.

j. Provideatentativeconstructionscheduleforcompletionoftheproje ctwithinthe specified Contract period. Indicate the following activities with milestones: Mobilization, radio communications licensing, submittal preparation, submittal review, equipment procurement, equipment assembly, system configuration and programming,factorytesting,systemdelivery,systeminstallation, startup,field testing and training, and post acceptance routine service intervals.

k. Describethesystemsupplier's provisions for service,technicalassistance andre- placement partsfortheproposedsystem. Include the systemsupplier's 1-800-toll

freenumber.Identifywithresumes,allpersonnelwhowillbeprovidin
gtechnical support services for the project after it is accepted.

TheContractorshallprovidetheaboverequireddetails/ documentsduringthebidsubmission.Failure tosubmitevenoneoftheabovewillbetreatedasanon-responsivebidandleadtotechnicalrejection of the bid. **Contractor shall note the importance of this obligation.**

GeneralSubmissions

The Contractor shall make submissions to the Engineer of all design drawings, schedules andcompletedocumentationonsparepartsrelatingtoinstrumentation,controlandAutomationequipment and systems provided under this Contract.

Thesesubmissionsshallinclude,whererelevant,thefollowing:

Functionaldesignspecification

TheContractorshallsubmitacomplete FunctionalDesignSpecification(FDS)for approvalbythe Engineer within 3 months of the award of contract. This document shall serve as the primary mechanism by which the Engineer may confirm that the Contractor possesses an accurate understanding of the system and its control requirements. The Contractor is encouraged to obtain clarificationsandto suggest refinementsto the controldescriptions contained inthis Specification.

TheFDS shallcompriseanoveralldescription ofthe plant,its functioning and control, anda detailed description of each section of the control systemcovering modes of operation, manual overrides, set- point and parameter selection and adjustment. The detailed description shall include a step-by-step controldescriptionwhichdefinesthefunctionofeachpieceofequipmentandeachcontrol actionand interlock, including details of the program in each programmable item. Proposed HMI screens shall form an integral part of FDS submissions.

The format of the programdetails may be chosen by the Contract, however it is suggested that this formatbechosentosatisfytherequirementsofthesoftware designdocumentation,ifapplicable,as described elsewhere.

TheFDSshalldescribethe‘fail-safe’featuresincorporatedintothedesignfortheevent offailureofa plant item or system, or loss of an input signal affecting a control loop or process sequence.

The FDS shall describe control actions taken and monitoring functions which remain available during apowerfailure,andanyautomaticcontrolsorsequencingwhichtakeplaceduringsystemstart-upand shut-down.

TheFDSshallbepresentedinaclearandprecisemannerandshallincludefigures ordrawingswhere appropriate.

The Contractor shall submit and obtain approval of the FDS from the Engineer before beginningthedetailedcontrolsystemdesign.Thecontractorshouldtakenote oftheimportance of this obligation.

Drawingsandschedules

(a) Processandinstrumentationdiagramwhichshallcomplywith BS1646and BS1553/equivalent ISA standard.

(b) Generalarrangementdrawingsoffield-mountedinstrumentsshowinginstallationandmounting details.

(c) Generalarrangementdrawingsofinstrumentandcontrolpanels,fully dimensionedinplanand elevation views, showing foundation and fixing details, access doors, clearances, cable-entry positions, weight and lifting arrangement.

(d) Layoutdrawingsofpanelfasciasshowinginstruments,controlsanddetailsof alllabels.

(e) Layoutdrawingsofpanelinteriorshowingequipment,terminalblocksandcableways.

(f) AlarmAnnunciatorarrangementandengravingdetails.

(g) Internalcircuitandwiringdiagramsforinstrumentandcontrol panels.

(h) Schematiccontroldiagrams.

(i) Instrumentloopdiagrams.

(j) Instrumentwiringandpipingdiagrams.

(k) Interconnectionwiringdiagrams.

(l) Cableblockdiagrams,drawingsandschedules.

(m) Instrumentsystemandpanelpowerdistributiondiagrams.

(n) Programmable-

devicefunctionaldesignspecificationswhichshallinclude hardwaredetails,logic flow charts, ladder diagrams and program listings.

(o) Schedulesofinputstoandoutputsfromprogrammablecontrollersandtelemetryoutstations.

(p) Labellingschedules.

(q) Comprehensivetestingschedulesforalloff-site,on-site,pre-commissioningandcommissioning tests and take-over tests.

(r) InstrumentSchedule,JunctionBoxSchedule,InstrumentandPLCDatasheets.

(s) CableTrayLayoutandSystemArchitecture.

(t) UPSdatasheetandUPSbatterysizingcalculation.

Allotherdrawingsnecessaryfortheprovisionofducts,openings,trenches,fixingholes forpanelsand the like andfor the complete understandingof the operation, maintenance andextensionof the system including any required for the Purchaser to dismantle, repair, maintain, modify or extend the Plant.

Dataandcalculations

(a) Manufacturers'cataloguesanddatasheets.

(b) Calculationstosupportcontrolsystemdesign.

(c) Specificationforprotectivecoatingsandpainting.

Certificates

(a) Manufacturers'workstests.

(b) Pre-installationchecks.

(c) Pressure-testingschedules.

(d) Instrumentlooptestchecksheets.

(e) Installedinstrumentperformancetests.

(f) Systemtests.

(g) Statutorycertificatesofcompliance(suchashazardousareaequipment).

Operationandmaintenance instructions

(a) Compositemanualdescribingthefunctionalandoperationofeachpieceofequipment.

(b) Compositemanualfortestingandservicingeverysystemandindividualitem.

Design

Basic Features

Instrumentation,Control,Automationsystemshallbedesigned,manufacturedandinstalledtoachieve the following basic requirements:

- to maintain the highest standards of availability, reliability and accuracy and to give clear warnings of any deterioration in performance;
- tosuittheabilitiesofthestaffwho will:
  - usethesystems;
  - servicethesystems;
- tomeasure,indicate,process,storeandcontroltherelevantparameters,asspecified;
- to give clear warnings of dangerous and other abnormal conditions and to initiate plant safety procedures, shutdowns andcorrective measures as specified to assure the safety of'operations and maintenance' personnel and plant and to store and collate the data, as required;
- toderive,presentandutilize,asrequired,suchadditionaldataasrequiredtofacilitate:
  - themostefficientoperationoftheplant;
  - theroutinemaintenanceoftheplant

DesignRequirementsforInstrumentation,ControlandAutomationSystems The instrumentation, control, automation installations shall fully comply with design standards, regulations and the material and workmanship requirements of the Specification.

Theelectricalplantinstallationsassociatedinstrumentationcontrolandautomation systemsshallalso comply with and be tested in accordance with the latest edition of BS 7671 or equivalent Indian standards.

Allequipmentandmaterialsincorporatedinthesystemshallbeselected,designed andratedtooperate under the defined performance duties and specified site conditions and to maintain a high level of operational reliability.

Theinstrumentationcontrolandmonitoringsystemequipmentandmaterialsshall haveanoperational life of not less than 15 years, unless otherwise approved by the Engineer.

Site Conditions

A. **TemperatureandHumidityRange**.Theequipmentshallbeinstalledinanenviron menthavinga temperature range of 0 °C to 55 °C and a maximum relative humidity of 100 % (non-condensing).

TheContractorshalluse,whererequired,fans,heaters,andairconditioningunitstomain tainacorrect workingtemperatureforhisequipment.AllPartsoftheequipment shallbeconstructedofmaterialsor treated to prevent the formation of mould, fungus or any corrosion over the temperature and relative humidity ranges specified.

B. **EMI/RFI Noise Immunity**.The equipment to be provided shall be adequately protected against interferencefromtheuseofradiotransmitters,atanypointexternaltotheequipmenth ousingsandno malfunction of the equipment shall result from this cause.Responsibility for the correct and reliable operationoftheequipmentshallrestwiththeContractor,whomustensurethattheequip mentis adequately protected against the ingress of radiated, mains-borne signal-borne interference.

C. **GeneratedInterference**.TheContractorshallensurethatthecomputer,inst rumentationand communicationsequipmentconformstoBSEN50081-1orequivalentIndianStandardfornoise emissions.

D. **Coordination**.TheContractorshallcheckwithothertradestoensurethatequipme ntandmaterial can be installed in space provided.Provide other trades with information necessary for them to executetheirwork.DetailsonDrawings,whicharespecificregardingdimensionsan dlocations,are forinformationpurposes.Coordinatewithothertradestoensureworkcanbeinstalle das indicated.

E. **Sequencing.**The Contractorshall make applications

tothelocaltelecommunications Service Providerforprovisionofcommunicationsandcoordinatewiththesub-contractorresponsiblefor installationofpowersupplyservicesunderthiscontract.Applicationsshallbemadeintimetoensure services are available for installation and commissioning of the telemetry equipment.

Enclosure/PanelDetails

Enclosuresandmounting boards

Enclosuresshall beanyformofboard,cabinet,panel,desk,boxorcaseusedto protect,containor group instrumentation, telemetry or control equipment.

Allequipmentinoronenclosuresshallbearrangedlogicallyand,asfaraspossible, symmetrically, with projections kept to a minimum. Each enclosure and board shall be designed on ergonomic principles and shall permit in-situ and safe access for any normal adjustment, maintenance and servicing. The tops of plant-mounted enclosures shall be sloped downwards from front to rear.

EnclosuresmountedinsidebuildingsshallhaveaminimumratingofprotectiontoIP54.

Enclosures for use outside buildings or in places where splashing may occur shall have a minimum rating of protection toIP 65 and have tops which project sufficiently to protect the vertical faces of the enclosure and any component mounted thereon from splashing, inclement weather and direct sunlight.Also,whenenclosuresforuseoutsidebuildingsarelocatedwhereexposureto direct sunlight will give rise to high top-panel surface temperatures such that the internal temperature rises above the manufacturer’srecommendation (normally40°C), the enclosure shall include asun shieldfitted to the top of the enclosure.Thesun shield shall preventdirectsunlight fromreachingtheinstrumentation for the full day throughout the year, and shall have louvered ventilation.

Fixingarrangementsforsurface-mountingenclosuresshallbeexternaltothe enclosureandshall ensure that the rear face of the enclosure is not in contact with the surface to which it is fixed.

Enclosuresshallhavehingedaccessdoors,fittedwithrecessedlockablehandles.

Doorsshallbeofrigidconstructionandprovidedwithclose-fittingflexiblesealsin recessestoprevent the ingress of liquids, moisture, dust and vermin. Hinges shall be of the lift-off pattern and one hinge shall engage beforetheother for easeof fitting. Wherever necessary, removable access coverssecured by quick-release fasteners shall be provided to ensure ease of maintenance for all installed apparatus.

Mountingplates,bracketsandracksshallbeprovidedforallotherinternal

equipmentwhichshallbe hinged or otherwise arranged with quick-release fasteners or captive screws to give quick and easy access to equipment, securing screws, terminals and wiring.

Enclosuresfortwoormoredeviceswithelectricalcircuitsshallhaveglandplates andterminalblocks as specified elsewhere.

Eachenclosureshallbedesignedforthesafetestingandservicingofequipment withthepoweron. Each part which may be live under any circumstances shall be so covered or shielded as to prevent inadvertent contact.

Paneldesign andconstruction

Unlessotherwisespecified,allinstrumentpanels,instrumentcubicles,control panels,controlconsoles and desks, associated equipment and terminal racks, telemetryand electronic equipment racks andthe like shall be free-standing, floor mounted units and shall conform to the requirements of this part and will hereafter be referred to as panels.

The design and dimensions of control consoles and desks shall be determined according to their intendedfunctionandshallbeinaccordancewiththe requirementsoftheSpecification.Theheight shall not exceed 1400mm above the finished floor level.

Unlessotherwisespecifiedtheheightofpanelsshallbenotgreaterthan2130mm overall(excluding lifting devices) above finished floor level.

Controls, switches and push-buttons shall be positioned below or adjacent to any associated reading instrument.Panelsforuseinlocationssuchaspumpingstationsandmachineryroomsshallh aveanti- vibration mountings.

Theclearancebetweentheextremitiesofapparatusmountedontheinternalwallsshallallo wsafeand unobstructed access to all terminals and to parts requiring maintenance.

Panel layout drawings shall normally include a list of all instruments, accessories and components contained therein. If the drawings have insufficient space for the list, a separate schedule of instruments,accessoriesandcomponentsshallbeprovidedandthepaneldrawingshal lcontainacross reference to the contents list and an indication of the panel location of each item on the list.

Panels-Major

Panels shall be constructed generally as specified in the preceding clause. Panel material shall be prime-quality,cold-rolledandannealedmildsteelorzinc-coatedmildsteelsheet,suitablybracedand stiffened as necessary with flat bar or angle to form a rigid structure.

Panelfrontsshallbeflatandfreefromboworripple.Exteriorcornersandedgesshallber oundedor welded and ground to give a smooth overall appearance.

Flangededgesshallbestraightandsmooth.

Materialsshallbechosenwithdueregardtothepanelsize,numberofcut-outs,instrumentweightand position of center of gravity and method of fabrication, with the following minimum thickness:

•Instrumentbearingsurfaces,glandplatesandpneumaticdistributionplates,3mm;

•Internalmountingplates,3mm;

•Doors,coversandfillerpanels,2mm.

Nodesigninvolvingtheuseofexternally-visibleassemblyorfixingboltsand screwsoranydesign resulting in dust or water-collecting crevices will be accepted.

When a panel is constructed in sections, the sections shall be designed for ease of assembly during installationand,inanycase,shallnotexceed2minlength.All necessarynuts,bolts,washersandthe like shall be supplied and included in the same shipment as the relevant sections. Sections exceeding 1m in length shall be provided with double doors.

Eachpanelshallbemountedonaself-drainingbaseframefabricatedfrom150mmdeep,steelchannel sectionwhichshallbedrilledor providedwithclampsfor boltingtothefloor.Thebaseframeshall be set back from the panel front face to give a toe space of not less than 25mm. The outside of the base frame shall be covered with an approved kicking strip.

Ceiling and other filler panels shall be fabricated from sheet steel and adequately stiffened. Each sectionshallhave50mmreturnededgesalongallfoursidesandshallbebracedtothema

insteelwork of the panel.

Achecker-platefloorshallbeprovidedinsideandabovethelevelofthebase frame,havingopenings suitable for the bottom entry of cables when applicable.

Sufficientremovableun-drilledglandplates,insectionsconvenientforhandling, shallbefittedclose to the appropriate terminal blocks and not less than 230mm above the panel floor or not less than 230mmbelowthepanel top.Theglandplates shall haveremovablesidecoversgivingaccess toboth sides of the gland plate and ensuring vermin-proof and dust-proof construction. Gland plates of a surface mounted enclosure may form a part of the base or top.

Panelscontaininginstrumentsusingafluidasthetransmissionmediumshallhavedistr ibutionplates with bulkhead unions for the termination of internal and external pipe work.

Alldoorsshallopenoutwardsandalldoorsinonepanelassemblyshallusethe samelockandkey combination.

Panel design shall ensure adequate ventilation and air circulation without permitting the entry of verminordust.Panelsinstalledincontrolroomsorotherclean conditionareasshallhavelouversto allow air circulation. Temporary closures shall be provided to prevent the entry of dust and vermin during transit and installation. After commissioning has been completed, all entries except air circulation louvers shall be sealed.

Noequipmentotherthanfront-of-panelitemsshallbemountedonpanelwall surfaces.

Ifelectricalandnon-electricalinstrumentsaremountedinthesamepanel,thepanel shallbe subdivided internally to separate the electrical and non-electrical sections.

Allconnectionsshallbearrangedtoensurethatnoaccidentaldamagetocablingor electrical componentscanoccurintheeventoffailureofanynon-electricalcomponentorconnection.

Provisionshallbemadeforsafeandeasyhandlingduringtransitand installation.

Ifliftingeyesareprovided,theyshallbereversibleandpaneltopsshallbereinforcedwhere necessary.

Where equipment is specified to be installed at a future date, space shall be allocated, and cut-outs withremovablemaskingplates,brackets,supports,wiring, terminalsandpipingandthelikeshallbe provided.

Panelsshallbefinish-coatedattheplaceofmanufacturebeforecommencingthe installationof apparatus and other fittings.

Panels-Minor

Panels for installation on the Plant which contain relatively few items of equipment, or where so specifiedelsewhere,shallbeclassedas minorpanelsandshallbeconstructedgenerallyasspecifiedin the preceding clause and comply with this Clause.

Panelsshall befabricatedfromsheet steel orother approvedmaterial lessthan 2.5mmthicksuitably braced to form a robust and rigid structure. Exterior corners and edges shall be rounded to give a smoothoverallappearanceandassemblybolts,screwsorrivetsshallnotbevisibleonth efrontface.

The design shall be such as to ensure adequate ventilation and air circulation where required, without permittingtheentryofvermin.Openingsforcablesshallbe madevermin-proof.Doorsshallbehinged and shall be provided with close-fitting flexible seals in recesses to prevent the ingress of liquids, moisture, dust and vermin. Unless otherwise specified, panels shall be suitable for floor mounting and shall not exceed 2130mm in height. Where surface-mounted panels are provided, the fixing shall prevent the ingress of moisture and the rear of the enclosure shall benot less than 10mm from thewall.

Liftingeyeboltsshallberemoved,issuedtothePurchaserandsubsequently replacedwithboltsafter installation.

Panels shall be extensible, and symmetrically arranged as far as possible with projections kept to a minimum.Wheretwoormorepanelsarefittedtogether,theyshallformaflush-frontedcontinuous panelofuniformheight.Front doorandtop cover dimensionsshall match.Instruments,relays,and controldevices shallbe mountedata height not more than 2000mmand not lessthan 300mmfrom floor level.

The arrangement of equipment within each enclosure shall be such as to permit easy access for installationandmaintenance.Noinstruments,relaysorother componentsshallbemountedonrear access doors or removable covers.

(a) **Localcontrolpanel(LCP):-**

LocalControlPanelshallbeprovidedforeachMotornearthedrive and shall be interconnected with MCC. The Local Control Panel shall have the following Provisions.

- 3Pushbuttons“START/STOP/EMERGENCYSTOP”
- Start/StoppushbuttonoperateswhentheswitchonLCPisin“MANUAL” position.
- EmergencyStoppushbuttonoperatesirrespectiveofthepositionoftheswitch.

WhentheselectorswitchonLCPisin“LOCAL”position,themotorwillbeoperatedbypushbuttons on LCP and will take into account only the specific fail-safe controls of the equipment (electrical protections, low level for a pump). When the selector switch on LCP is in “REMOTE” position the drive will be operated from PLC.

(b) MotorizedValves(FieldType):-

MotorizedvalveswillusefullyintegratedcontrolActuator.Theactuatorcomeswithintegrated:

- Selectorswitch“Remote”/“Local"
- P.B’sfor:OPEN/CLOSE/ STOP.

Note:NecessaryFieldIndicatingdevices(Where-everprocessInterlocksareapplicable)andLED’s (Motor’s, Actuator’s etc., of feedback Indications) shall be provided on LCP’s for Manual control operations.

Panels–Composite

In situations where space limitations preclude the use of separate instrumentation, control and automation(ICA)andswitchgearpanelsand,atthesolediscretionoftheEngineer,ICA equipment may be combined within a single enclosure subject to the following conditions:

- Theobservanceofallotherclauseshereinrelatingtoenclosures,mountingboardsandminorpanels;
- ThewrittenassuranceofeachsupplierofICAequipmentthattheproximity oftheswitchgearwill have no detrimental effect on the life or performance of any ICA component;
- ThetotalsegregationofICAequipmentandswitchgearincludingtheglandingandtermination facilities;
- Theabsenceofanyvoltageexceeding250vacor50vdcfromanycompartmentcontainingICA equipment;
- Theuseofthefull heightofthepanel(excludingthebusbarchamber and Cablespace)foranyICA equipment compartment.

Panelprotection

Adequate facilities for isolation and protection by miniature circuit breaker or fuse for each instrumentationandcontrolcircuitandsub-circuitshallbeprovidedandshallbesoarrangedthatany interruption causes minimum disruption of plant, operates the appropriate alarm and cannot result in any unsafe operating condition.

All fuses shall be of the cartridge pattern and main fuses shall be of the high rupturingcapacitytype. Fuse and solid-link carriers and bases shall be of plastic molded insulating material of an approved make. Ceramic materials will not be accepted. Live connections shall be efficiently shrouded and it shall be possible to change fuses with power on without danger of contact with live metal. The fuses shall be rated to give maximum protection to the equipment in circuit and the rating shall be permanentlyinscribedonthefuselabelandonthefusecarrier.Unless necessaryfortheprotectionof particularequipment,miniaturecircuitbreakersused forindividual circuitsinapanel orcontrol desk shall not trip on over-voltage or under-voltage.

Bases for solid links shall not be interchangeable with those for fuses. Fuses and links in the same circuit shall be mounted opposite each other in separate adjacent rows and shall not alternate in the samerow.Atleast10%andnotlessthantwo unallocatedminiaturecircuitbreakersorfusesandlinks shall be provided ineach panel distribution board.Miniature circuit breakers andfuses of similar size and rating shall be of the same make and type.

At least10%,andnotlessthantwo,sparefusesandlinksof eachratingshall be providedandfittedin clips inside the panel.

Each instrument requiring a power supply shall be individually wired and protected so that, in the event of a failure in one circuit, the remainders are unaffected. Power supply circuits shall be of sufficientratingthatanyprotectivedevicemayoperate withoutreducingthevoltageattheterminals of any other component to an unacceptable level.

Panelisolation

Clearly-labeledisolatingcircuitbreakersshallbeprovidedforeachincoming powersupply.Switches shall be of the quick make-and-break type with spring loaded contacts that close fully without requiring full operation of the handle. The handle and cover shall be interlocked so that the handle cannot be operated when the cover is open and the cover cannot be openedunless the switch is inthe ‘off’ position. The ‘on’ and ‘off’ positions of each switch shall be indicated clearly.

Circuitbreakersforpanelpowersuppliesshallbemountednearanaccesspointand inpositionswhere they may be operated easily from a standing position.

Plug-inisolatinglinksor devicesofanapprovedtypeshall beprovidedinany circuitthat maystill be live when the power supply isolators are in the ‘off’ position, as, for example, in circuits controlling equipment whose power supply is independent of the panel. Such links or devices shall be properly screenedand,ifnotincorporatedinoradjacenttotheirassociatedoutgoingterminals,s hallbe labeled with suitable warning notices.

Any item of panel equipment to which panel internal wiring is connected with a plug and socket insteadofterminalsshall bewiredinflexiblecableofadequate ratingbetweenthe‘free’pluganda socket mounted adjacent to the device.

Thepowersupplyconnectorshallbeasocket.

Panelterminalblocks

Externalwiringforpanelpowersuppliesshallbeterminatedontheappropriate isolator.Signalcables from strain gauges, analyzers, resistance thermometers,

retransmitting slide-wires and thermocouples may be terminated at their appropriate instruments.

A terminal block shall be provided as the interface between the corresponding conductors of each internal and external wire and each internal and external connection except those listed above. The terminalblocksshallbemounted verticallywherepossibleandnotnearerthan230mmtotheflooror less than 230mm from an incoming cable gland.

Terminalblockrowsshallbespacedapartbynotlessthan150mmandarrangedto permitconvenient access to wires and terminals and to enable ferrule numbers to be read without difficulty.

Other circuits shall be grouped on the terminal blocks according to the classification given in the clausefor‘Panelinternal wiring’ whichshallbe clearly marked alongthe correspondingsection of eachterminalboard.Groupsof differentvoltagesonthesameboardshallbeseparatedbyinsulated barriers.

All connections shall be made from the front of terminal blocks and no live metal shall be exposed at the back. All terminal blocks shall be of the type which clamps the wire securelyand without damage between two plates by means of a captive screw and which permits removal of any terminal without disturbance to adjacent terminals. Pinch-screw type terminal blocks will not be accepted. Terminal moldings shall be in melamine to BS 1322, polyamide or equivalent. Terminal rails shall be hot-dip galvanised. Current bars between the two connection points of each terminal block shall be of copper or brass with tin/lead alloy plating. All steel parts shall be zinc-plated and passivated with a yellow chromatelayer.Terminal blocksforinput andoutputanaloguesignalsandforcircuitscontainingvolt-freecontactsinternalorexternaltothecabinetshallbeoftheKlippontypeSAKCor equivalentwhich permit the connection of a test milli-ammeter or continuity meter without disconnecting any wiring.
Terminalblocksforpowersuppliesfor equipmentexternaltothepanelshallpermittheisolationofthe item of external equipment without affecting the operation of any other circuit within or outside the panel.

Nomorethanonecoreofexternalcablesortwointernalwiresshallbeconnected toanyterminal.If terminal blocks are used as common points for two or more circuits, individual terminals with the appropriatenumber ofpermanent cross connections shall beprovided.Thelengthsofexposedcable cores shall be sufficient to reach any terminal in the appropriate row or rows. The cores shall be formed into a neat loom and a separate loom shall be provided for each cable.

Eachrowofterminalblocksshallcontainatleast25%spareterminalsoverthe numberrequiredfor terminating all cores of external cables in that row. Unless otherwise specified, each external cable shall contain at least 20% spare circuits, with a minimum of one spare circuit.

Terminal blocks shall be numbered consecutively in a sequence different from that used for identifying wiring. The terminal numbers, voltage grouping and terminal board layout shall correspondpreciselywithwiringdiagramssothatquickand accurateidentificationofwiringcanbe made.

All theterminal boardsshall be provided withcovers of transparentinsulating materialthat does not sustain combustion and shall be sectionalized where possible to give access to groups of terminals withoutuncoveringallboards.Terminals whichmaybelivewhenthepanelisisolatedfromitsmain supplies shall be suitably labeled to minimize the risk of accidental contact.

Panelinternalwiring

Panelcircuitsshallbesegregatedintothefollowingcategories:

Group1:Powercontrolandvery-high-levelsignalwiring(above 50V):

ACpowersupplies;

DCpowersupplies;

ACcurrentsignalsabove50mA(suchasCT circuits);

ACvoltageandcontrolsignalsabove50V(suchasPT circuits).

Group2:High-levelsignalwiring(6Vto 50Vdc):

Signalsfromconventionalelectronictransmittersandcontrollers(sucha sdigitalor4mAto 20mA);

Circuitstoalarmannunciatorsandothersolid-statedevices

Digitalsignals;

Emergencyshut-downandtrippingcircuits;

On/offcontrolcircuits;

Intrinsicallysafecircuits;

Group3:Low-levelsignalwiring(5Vdcand below):

Signalsfromthermocouples;

Signalsfromresistancethermometersandre-transmittingslide-wires;

Signalsfromanalyticalequipmentandstraingauges.

ForGroup3wiring,internalconnectionstotheinstrumentsshallbemadebyoneof thefollowing methods:

(a) Thetwisted,screenedconductorsoftheexternalcableshallbeleddirectto theirappropriate instruments via ducting systems installed for this purpose during construction of the panel;

(b) The conductors of the external cables shall be terminated on terminals segregated fromall other categoriesandtheconnectionstotheappropriateinstrumentsshallbemadeusingt wistedpairswith individual screening installed for this purpose during construction of the panel.

InternalwiringforallcircuitsinGroup2exceptthosesharingacommon connectionshallbemulti- stranded, twisted pair, 0.75mm² minimumcopper conductor with HPDE or PVC-insulated cable of adequate grade and rating.

Wiringforcircuits inotherGroupsorsharingacommonconnectionshallberuninstranded,1.0mm² minimum copper conductor with 250V grade, PVC-insulated cable of adequate grade and rating.

Wiring sheath colors shall be black for ac circuits, and grey for dc circuits (excluding thermocouple circuits)andblueforGroup2.6circuits.Circuitssuppliedat240V, between240Vand110Vdcshall also be physically segregated from each other and from other circuits. Access to wiring and components of circuits having voltages exceeding 240V shall not be possible unless and until the circuit has been isolated.

Separate ducts, trunking, cable looms, tray work and the like shall be provided within the panel for eachcategorywithatleast150mmbetweenparallelpathsof Group1andthoseofanyotherGroup. Intrinsically-safe circuits and their terminals shall be segregated from other circuits and terminals.

All wiring shall be neatly and securely fixed by insulated cleats, bunched and secured by approved plasticstrappingorrunin

approvedinsulatedwiringtrunkingornon-corrodibleflexibletubing.Not more than **75%** of the capacity of trunking, ducts, looming, or tubing shall be used. Insulated earth wiring shall be so arranged that access to any equipment or connection point or the removal of any item of equipment is unimpeded.

Wiring for future equipment shall be secured and terminated on terminal blocks. Lacing for wiring loomsshallbeofrot-proofcordorplasticstrips.Inter-sectionwiringinmulti-sectioncabinetsshallbe via a terminal block in each section.

Panelwiringidentificationandtermination

Identification ferrules shall be fitted at both ends of each wire. The numbers or letters used shall correspond with the appropriate wiring diagram. The ferrules shall be of plastic insulating material withpermanentblackcharactersonacolorcoded backgroundfornumbersandonawhitebackground for letters, unaffected by oil or water. They shall be so arranged that they can be read logically from left to right when viewed normally.

The system of wire identification shall be such that wires in the same circuit on opposite sides of a terminalshallhavethesamereference,andthissystemshallbe continuedthroughallexternalcabling.

Terminalferrules(spade,tongue,crimpedconnections)shallbeprovidedoneach conductor.

PanelEarthing

Acontinuous copperearthbar of not lessthan25mmx 6mmcross section shall run thefulllength of each panel and shall be securely fixed and bonded electrically to the main frame. The cable gland-platesandtheearthbarshallbeprovidedwithsuitablebrassterminalsofnotlessthan6 mmdiameter for connecting the metal cladding or armouring of all incoming and outgoing cables to the station earthing system.

Asecondcontinuous copperearthbarofnotlessthan25mmx6mmcross section, electricallyisolated from the steelwork of the panel and metal cladding and armouring of cables, shall be provided for earthing the signal earth connection of each instrumentation and control device and the screen(s) of each instrument cable not earthed elsewhere to the station instrumentation earth plate. The earth bar shall have sufficient brass terminals as specified above for each instrumentation and control device and the screen of every shielded cable plus 25% spare terminals.

Inmulti-sectionpanels,eachearthbarshallbeelectricallybondedtothe correspondingbarsinthe adjacent section(s).

The earth pit for instrumentation system shall be separate.Electric earth pit shall not be used for earthing of instrumentation equipment. All signal cable screens (analogue and digital) shall be terminatedontotheinstrumentearthbar.Signalcablescreensshallbeearthedattheco ntrolpanelend only.Screens at the field end shall be tied back and insulated.

SPDsassociatedwiththecontrolandinstrumentationsystemshallbeearthedtotheins trumentearth in accordance with the SPD manufacturer’s recommendations.

Panellighting

Eachpanelshallbeadequatelyilluminatedinternally,as evenlyandasfreefromdazzleaspossible,by fixed fluorescent lightingcontrolled fromtotally-enclosed light switches and by totally-enclosed door- operated switches positioned so as not to interfere with access. There shall also be one installed inspection lamp per three metres of panel length or part thereof with adequate flexible connectioncable to reach any point in the panel. The control switch for an inspection lamp shall form part of the lamp assembly. Lighting circuits shall be fused independently of any instrumentation and control circuitanddesignedtoallowlampstobereplaced safelyandshallbefedfromadistributionboardand circuit breaker connected on the live side of the main panel ac supply circuit breaker.

Panelventilation

Each panel shall be provided with ventilation fans as required to ensure that equipment within the panelismaintainedwithinmanufacturer’srecommendations, withdueregardtotheenvironmentin which the panel will be mounted. Fans shall be controlled by a suitably-labeled enclosed switch mounted internally in an accessible position.

Fansshallbemountedwiththeiraxeshorizontalandshallbearrangedtodraw cleanairintothepanel. Air entries shall have filters which can be renewed from outside the panel and shall be designed to prevent the entry of rain, spray, injurious fluids, sand or dust.

Panellabels

All control gear shall be fully labeled with the KKS code identifying the equipment designation/function,allexternalandinternalcomponents,all ratingdata,detailedequipment operating data and for danger and hazard warning.

Labels shall be provided for every panel to describe the duty or otherwise identify the panel and its sectionsandeveryinstrument,componentanditemofequipment mountedinternallyandexternally. Where applicable, front-of-panel labels shall be as detailed in the Specification. Wording shall be clear, concise and unambiguous and shall be subject to review by the Engineer before manufacture. Each label shall be permanently secured to the surface near the item to which it refers. Externally- fitted labels shall beof Perspex orother approved transparent plastic, withletters and numbers rear- engraved and filled with black.

TherearsurfaceofeachPerspexlabelshallbefinishedwithacoat ofpaintofthesamecolourasthe panel external finish. Instrument duty labels fitted externally shall be below the item to which they refer. Embossed tape or similar adhesive labels will not be approved.

Laminatedmaterialsorrear-engravedandfilledplasticshallbeusedforinternallyfitted labels,which shall be white with engraved black letters.

Labelsconformingtotherequirementsoftheprecedingparagraphsorotherapprovedmeansshallbe provided:

•Todescribeoridentifycircuitsorcircuitcomponents;

•Toidentifydcpolarity;

•Towarnorremindaboutdangerousorpotentially-dangerouscircumstances;

•Whereverelsewherespecified.

Unlessotherwisespecified,allengravingshallbeinplainblockletters,4mmhigh.

Theminimumpracticablenumberofdifferentsizesshallbeused.

Manufacturers’nameplatesshallnotbefittedonpanelexternalsurfaces.

Panelfinish

For control and instrument panels, desks and cubicles a hard, smooth, durable finish, free ofblemishes, shall be provided. Before painting, all external welds and any rough areas shall be smoothed, andall surfacesshall bethoroughlycleanedand freefromscale,contaminates, corrosion or grease. If rust-proof or Zintec steel has not been used in the construction, the panel shall be treated with a passivating agent such as phosphoric acid. All internal surfaces shall have a minimum of three coats of paint of which the first shall be an approved anti-rusting priming coat and the final coat shall be opaque gloss white enamel. All external surfaces shall have not less than five coats of paint of which the first shall be an approved etch-priming coat, and the second and third suitable undercoats, allofwhichshall berubbedsmoothwhendrybeforeapplicationofthenextcoat.Theundercoatsshall be easily distinguished in shade or colour from the priming and finishing coats. The two final coats shall be of stove enamel paint, gloss or semi-matt finish, to a colour and finish to be advised by the Engineer. Stoving shall be carried out in accordance with the recommendation of the paint manufacturer.

Theoveralldryfilmthickness(DFT)shallbebetween85and120microns.

Nuts,bolts,washersandotherfixingdeviceswhichmayhavetoberemovedfor transitor maintenance purposes shall be galvanized or otherwise finished to an approved standard.

Instrumentsand ancillaries

General

Allinstruments,gaugesandcontrolequipmentwhichperformsimilardutiesshall beofuniformtype and manufacture throughout the Works in order to facilitate maintenance and the stocking of spare parts.

All equipment shall be fully tropicalised and suitable for the worst environmental operating conditions.Panel-mountedinstrumentsshallbeoftheelectrically operatedflushmountedtypeand shall have damp-proof and dust-proof cases.

Instrumentsmountedoutsideinstrumentpanelsshallhaveweather-proofanddust-proofcases. Instrument cases shall be of corrosion-resistant material or finish.

Instrument screws (unless forming part of a magnetic circuit) shall be of brass or bronze. Access to terminalcompartmentsofinstrumentsmountedoutsidepanelsor otherenclosuresshallnotexposeany workingpart.Movingpartsand contacts shallbe adequatelyprotectedfromtheingress ofdust. Where applicable, Instruments shall be easily withdrawable from its housing for maintenance without interrupting its signal.

Unless otherwise specified, instruments shall be finished in the manufacturer's standard colour. Instrumentdialsshallbeofsuchmaterialthatnopeelingor discolourationwilltakeplacewithage under tropical conditions.

Plant-mountedindicatorsandgaugesshallbesizedtogivefulllegibilitywhen viewedfromaposition with convenient and easyaccess orfromthepoint at whichanyoperation requiringobservation ofthe gaugeisperformed.Theminimumdiameterforanygaugeshallbe150mmexceptwher eformingpart of standard instruments and accessories such as air-sets.

Dialsandbezelsshall beofbronzeandinternalcomponentsshallbeofstainlesssteel,bronzeorother corrosion-resistant material.

Unless otherwise specified, all functions shall be transmitted electrically and all analogue signal- transmissionsystemsshallbeinaccordancewithBS5863:Part1 orequivalentandshalluseasignal of digital or 4mA to 20mA DC. Where possible, measuring systems shall be designed so that any necessary power supply is taken from the appropriate instrument panel.

Transmittingdevicesshallhaveintegralindicatorstomonitortheoutputsignalor connectionssuitable for use with a portable test meter, and shall be capable of meeting the performance requirements specified in the appropriate part of BS EN 60770-1or equivalent. For the important and critical processes the transmitting devices, such as pressure, temperature and level gauges, shall have a reference gauge installed locally for easy reference for the operation and maintenance staff.

ThetransmittersshallbeprovidedwithLCDmeters.

Equipmentmountedinenclosuresshallbesuitableforcontinuousoperationatthemaxi muminternal temperature possible in service, due account being taken of internally-generated heat and heat dissipated by other plant. All components shall be rated adequately and circuits shall be designed so that change of

component characteristics within the manufacturers’ tolerances shall not affect the performance of plant. All equipment shall be designed to operate without forced (or fan) cooling.

Equipmentprovidedwithanti-condensationheatersshallbecapableofoperatingwithoutdamageif the heaters are left on continuously. Unless provided with unalterable factory configured ranges, measuring instruments shall have zero and span adjustment.

Fieldmountedinstrumentsshallbemounted suchthattheyareeasilyviewableand easilyaccessible for maintenance.

Instruments not mountedinpanels shall besupplied complete with all brackets, stands, supporting steelworkandweatherproofenclosures(separatefromthe instrumentcases)necessaryforsecuring themin their workingpositions and affordingcomplete protection at all times includingperiods of servicing, adjustment, calibration and maintenance.

Each installation shall incorporate a valve and pipe work for obtaining a sample representative of the fluidatthepositionofthepermanent meteranddrain.Ifthemeasuringandsamplingpointsareremote from each other, the test and sample facilities shall be provided at both points.

In order that maintenance and inspection may be carried out safely and conveniently instruments mountedinelevatedandopenworkareasshallbeprovidedwithsafetyladdersandasufficientlysized working platform with sun shading.

IndicatingInstrumentsandMeters

General

Allinstrumentsandmetersshallbeflushmountedandgenerallyofthesamepattern andappearance throughoutandthosewhichperformsimilardutiesshallbeofuniformtypeandmanufacture.

Indicatinginstrumentsshallbefittedwithanexternallyaccessiblezeroadjuster.Theysh allhaveno parallaxerrorandtheirnormalmaximumreadingshallbeapproximately60%fullscale deflection.

Ammetersinmotorstartercircuitsshallbecapableofwithstandingthestartingcurrentandshallhavea compressedoverloadscale.Theammetershallhaveanadjustableandsealableredpointersettoindicate normalfullloadcurrent.Theammeterphysicalsizeshallbeinkeepingwiththesizeofthestarter concerned. The minimum size to be used is 0.25 DIN.

IndicatinginstrumentsshallcomplywithIS1248,BS89orIEC60051andshallbeofindustrial grade accuracy.

(a) **PanelMountedDigitalIndicatorsForFieldInstruments**

Digitalpanelindicatorsshallbemicroprocessorbasedandmodularindesign.Itshall accept4-20mA DCisolatedinput.Thedigitalpanelindicatorshallprovideanoutputof4-20mADCproportionalto inputsignalforretransmission.ItshallhaveRS485communicationportforconnectivitytoPLC.

TechnicalParticulars

Type	:	Microprocessorbased.
Mounting	:	FrontfaciaofInstrumentControl Panel(ICP)
Display	:	Back-litLCDorLED
Digitheight	:	12.5mmor higher
No.ofdigits	:	4
Input	:	4-20mADC(isolated)
Zero&Span adjustment	:	Required
Engineeringunitsfordisplay	:	Aspersiterequirement
Weatherprotectionclass	:	IP-52oflS13947
Retransmissionoutput	:	4-20mAproportionaltoProcess variables.
Relayoutputs	:	Required2NO+2NCforhigh level alarmand2NO+2NCforlowl evel alarm
Communicationport	:	RS-485(WithModbus protocol)

(b) **Kilowatt-hourmeters.**

Kilowatt-hourmetersshallcomplyfullywithIS722orBS5685Class2andshallhaveindustrialgrade accuracy(±2.5%).Threeelementunitsshallbeusedfor3phase4-wiresystems.Twoelementunitsshall be used for 3 phase, 3-wire systems.

Quantity : 1No.foreachpumpandincomersof3.3kV(ormore) Switchboard(250KW&abovemotors) As per site conditions.

Purpose : PowerandEnergyMonitoring

Itshallmonitorvoltage,current,kW,kVAr,kVA,powerfactorandfrequency.

TechnicalParticulars

Datalogging

DatastorageanditshallberetrievedviaRS485

port Soft Integration

ThemetershallbeintegratedwithHMIsystemtoprovideremotedisplayofallmeasured parametersand meter configurations.Themeteringshall be via. RS 485 port.

Measurement

-
- TrueRMS measurement
- Instantaneousphasevoltages,linevoltages,phasecurrentsandlinecurrents
- Frequency
- Active,reactive,apparentpowersandpowerfactorperphaseandline
- Energy-ImportandExport
- MaximumdemandkVA,kW,kVAr

Communications

- RS485

- Baudratesminimum9600

AccuracyClass

- 0.5 S

AccuracyStandards

- IS-14697:1999

FrontPanelDisplay

- LCDwithbacklighting
- Displayforallbasicpowerandenergyparameters
- Passwordprotectionforsetuppar

ameters Ratings

VoltageInputs

- 50to347VAC
- AccuracyVL-N:0.25%reading
- AccuracyHz: +/-0.1 Hz
- Support3phase3wire,3phase4wireconnections
- Standardscrewinterminals

Current Inputs

- 5Amps.nominal
- Accuracycurrent:0.25%reading
- 20%overrangefullaccuracy

PowerSupply

- 110Vto240VAC&VDC

EnvironmentalConditions

- AsperprocessRequirement-Ambient Temperature.
- Humidity:upto95%nonconde

nsing Dimension:Approx.

96×96×96 mm

(c) **MicroprocessorbasedAlarmAnnunciator**

(1) Microprocessorbasedalarmannunciatorshallbeprovidedforgeneratingaudio-visualalarms foreachabnormalcondition.Alarmsshallbeinitiatedbytheopeningandclosingofvolt-free contactswhichshallremainunchangedthroughouttheperiodsinwhichthealarmconditions exist.Alarmcircuitsshallbecapableofconversionfromopen-healthytoopen-alarmorvice versabyasimpleconfigurationafterinstallationrequiringnoadditionalpartsorspecial equipment.Eachalarmshallinitiatetheoperationofbothvisualandaudibledevices.Thesound intensity(adjustable)ofeachaudibledeviceshallbesuitableforthemaximumsoundlevelofits environment.

(2) Eachalarmshallinitiateavisibleandaudibleindicationofthespecifiedcondition.Unless otherwisespecified,alarmindicatorsshallbegroupedtogetherinannunciatorunitseachhaving atleast20%sparewindows.Eachalarmwindowshallconsistofminimum2nos.ofbulbs havingclusterofLEDsandshallhavescreensengravedwithlegendsapprovedbythe Engineer's Representative.

(3) Whenanyalarmconditionoccurs,anaudibledevicecommontoanalarmannunciatorsystem shall sound and the appropriate indicator shall flash on and off. The flashing rate shall be selectable. Facility for selection of type of sequence shall be provided.

(4) Theoperationoracceptanceofonealarmshallnotinhibittheoperationoftheaudibledevice or the flashing of the appropriate alarm indicator if a future alarm condition occurs.

(5) Anintegral'test'pushbuttonshallbeprovidedtoilluminateeachlampandtooperatethe audible device but shall not cause a spurious alarm condition.

(6) Alarmcircuitryshallbearrangedsothatspuriousortransientalarmstatespersistingforless than 0.5 seconds adjustable do not initiate any action.

(7) Isolationfacilityshallbeprovidedforthehooters.

(8) Alarmannunciator/ indicatorlegendsorlabelsshallbearrangedwiththreelinesoftextas follows:

i.	top line	:	Location
ii.	middleline	:	Parameter
iii.	bottomline	:	Status
e.g.		:	WETWELLLEVEL LOW

(9) AlarmannunciatorshallhaveRS-485communicationport(Modbusprotocol)forinterfacing with the PLC system.

(10) ALEDshall beprovidedtoindicatethe'ON'statusofthealarmannunciator.

TechnicalParticulars

Alarmannunciatorshallbeprovidedoninstrumentcontrolpanelforannunciationofalarmsincontrol room. The technical particulars of alarm annunciator are as follows:

i.	Type	:	Microprocessorbased,splittypewithalarm windows mounted on the frontdoor and electronic modules inside the panel.
ii.	Mounting	:	Flushwithpanel
iii.	Construction	:	Modular
iv	Inputs	:	Potentialfree,NO/NCcontacts
v	Sizeof windows	:	60mmX 26 mm
vi	Operatingsequences	:	Firstup(userselectabledipswitch)
vii	Bulbsper channel	:	2(Cluster LEDs)
viii	Push Buttons	:	ForTest,Mute,Acknowledge&Reset

ix	Hooter	:	Required,electronictype
x	Powersupply	:	24V DC/240V AC
xi	PowersupplystatusIndication	:	Required
xii	Weatherprotection	:	IP-52ofIS 13947
xiii	No.ofWindows	:	8/ 12/ 24,Asrequiredwith20%Spare
xiv	Quantity	:	Asperprocessrequirement

IndicatorLights

Indicatorlightsshallbenotlessthan20mmdiameterandshallbepanelmountedtypeswithmetal bodiesadequatelyfastenedsothatthelampsshallbecapableofreplacementfromthefrontofthe apparatuswithoutdisturbancetothelampholderorpanelwiring.Lampholderssshallbekeyedinto panelstopreventrotation.LenscolourshallcomplywithBSEN60037asfollows:

- poweron : white*
- running- : green
- tripped/alarm : red
- status(open,closed,etc): blue
- readytostart : blue
- warning(noimminentdanger):amber

Note: *whitemaybeusedwheredoubtexistsastowhichothercolourtouse.

Thelightsshallbeunder-runtogivelonglifeeitherbyuseofaresistortolimitvoltageto90%normal value or by using higher voltage lamps.

Theindicatinglampsoncontrolpanelshallbeclusterof LED's.

Pushbuttons

Coloursofpushbuttonsshallgenerallycomplywith IS6875,BSEN60947,60037orIEC6007 3andin particular shall be as follows:

- stop,emergencystop : red

- start : green
- jogging/inching : black
- reset(whennotalsoacting asastop) : blue
- lamptest : blue
- override/alarmaccept : yellow

SpecificationforJunction Boxes:

(A)Junctionbox(instrument)

1	Construction	:	3mmsheetsteelhot
2	Protection	:	IP65
3	Paintandshade	:	Onecoatofredoxideprimer Powdercoatedlightgrey asper Dhade 631 of is:5
4	Terminalstrip	:	Elmextypecapableof Terminating0.5sq.mmto1.5sq.mm Cable din rail mounted
5	No of terminal strips	:	30/40/70Rating: 600V10AAC
6	Conduit&cable entry	:	Lowerside
7	Glandplantthickness	:	3mm
8	DoorofJB	:	Hingedwithproperlocking Arrangement to avoid entry of Dust & moisture the design of Fixing screws of the lids of the Junction box shall be such that

Theydonotcomeoutoftheli
ds When completely
unscrewed

			(captivescrews)
9	Dimension	:	Vendortoprovidemost EconomicdimensionofJBbased OnthenoofTerminalbasesandcable Entry
10	Mounting	:	Framemounted
11	Earthing	:	Twonos.ofearthingboltsforJB Earthing separate instrument Earthbusoninsulatingcl itsto be provided
12	Nameplates	:	Tobeprovidedmaterial:white Engraved letters on black Anodized aluminum sheet Fixing:stainlesssteelsc rews Lettering:- blackwithwhite Engraved

(B)Junctionbox(power&control)

1	Construction	:	3mmsheetsteelhot
2	Protection	:	IP65
3	Paintandshade	:	Powercoatedlightgreyas per Shade631ofis:5
4	Terminalstrip	:	Elmextypecapableof Terminating0.5sq.mmto1.5 sq.mm Cabledinrailmounted
5	Noofterminalstrips	:	30/40/70
6	Conduit&cableentry		Lowerside

7	Glandplatethickness	:	3mm

8	DoorofJB	:	Hingedwithproperlocking Arrangement to avoid entry of Dust & moisture the design of Fixingscrewsofthelidsofth e Junctionboxshallbesuchth at Theydonotcomeoutofthelid When completely unscrewed (captive screws)
9	Dimension	:	Vendortoprovidemost EconomicdimensionofJBbased OnthenoofTerminalbasesandc able Entry clearly specifying GA Drawing
10	Mounting	:	Framemounted
11	Earthing	:	Twonos.ofearthlingboltsforJB Earthing
12	Nameplates	:	Tobeprovidedmaterial:white Engraved letters on black Anodized aluminum sheet Fixing:stainlesssteelsc rews Lettering:- blackwithwhite Engraved.

Cabling

Instrumentationcabling

Cables from conventional measuring transmitters and analogue process controllers, such as digital or 4mAto 20mAdc output froma constant-current source, (hereinafterreferredto ashigh-level signals) shallbepolyethyleneorPVCinsulated withstrandedconductorsandlaidupastwistedpairswithone twist per 30mm approx. Each cable shall have an overall screen of braided copper or Mylar backed aluminiumfoil giving a minimumcoverage of 85%, a steel wire armouring insulated fromthe screen and from any ducting and an overall PVC sheath. For runs exceeding 30 metres or for all inputs to a datalogger, computer or microprocessor, multi-core cablesshallhave an individual screen of braided copper or Mylar-backed aluminium foil for each signal pair. The minimum conductor size shall be 24/0.2mm but shall be of greater cross-sectional area if required for the satisfactory operation of associated plant. Cables for intrinsically safe systems shall comply with BS 5308 and the relevant certificate.

Cablesfromstraingauges,analyzersandthelike,suchas0to100mV (hereinafter referredtoaslow- level signals — see also below) shall be as specified above and shall have an individual screen for each signal pair.

Cablesfromindicatingdevicestoalarmortrippingcircuitsshallbeasspecified aboveforhigh-level signals but shall use cables, cable trays, ducts and conduit separate from those for other high-level circuits.

Cables for high-level signals, low-level signals, resistance thermometers and thermocouples shall be segregated from each other and each shall be separated from cables for power, communications and other electrical services. Other cables run in the vicinity of instrumentation cables shall be twisted at therateofonetwistper 50mmapproximatelyandshallbeseparatedfrominstrumentationcablesbya distance of not less than 300mm.

Initiating devices for plant protection and personnel safety shall be connected by individual cables direct to the tripping or safety device and shall not be routed via any intermediate junction, marshallingbox,cabinet,relayorsimilar.Theouter sheathsofsuchcablesshallbecolouredorange.

Technicalparticulars

(i) Contractor shall include in his scope the supply, laying of cables and associated civil/mechanical work.

(ii) Cables shall be capable of satisfactorily withstanding without damage, transportation to site, installation at site, and operation under normal and short circuit conditions of the various systems to which the respective cables are connected when operating under the climatic conditions prevailing at the site as indicated in this specification.

(iii) Cablejointsininstrumentsignalsandpowersupplycablesshallnotbe permitted.

(iv) Cables shall be capable of satisfactory performance when laid on trays, in trenches, conduits, ducts and when directly buried in the ground.

(v) Cables shall be capable of operating satisfactorily under the specified power supplysystem voltage and frequency variation.

a) Cablesforanalogsignals

Thecablesshallcomplywiththefollowingrequirements:

Cables of 1100V grade, multi-pair/multi-triad cable, annealed, tinned, high conductivity, 1.5 sq. mm. stranded copper conductor, extruded PVC insulated two/three cores twisted into pair/triad, laid up collectively,individualpair/triadshieldedandoverallshieldedwithaluminiumMylartape,ATCdrain wire run continuously in contact with aluminium side of the tape, inner sheathed with extruded PVC, armoured with galvanized steel wire and overall sheathed with extruded PVC conforming to IS 1554, IEC 189 & BS 5308 shall be used for analog signals.

b) Cablesfordigital signals

Thecablesshallcomplywiththefollowingrequirements:

Cablesof1100Vgrade,multicorecables,annealed,tinned,highconductivity,1.5sq.m

m.stranded copper conductor, extruded PVC, overall shielded with aluminium Mylar tape, inner sheathed with

extrudedPVC,armouredwithgalvanizedsteelwire,overallsheathedwithextrudedPVCconforming to IS 1554,IEC 189 & BS 5308 shall be used for digital signals.

c) CablesforInstrument/Equipmentpowersupply

Thecablesshallcomplywiththefollowingrequirements:

Cables of 1100V grade, multi-core cable, annealed, tinned, high conductivity, 2.5 sq. mm. stranded copperconductor,extrudedPVC,innersheathedwithextrudedPVC,armouredwithgalvanizedsteel wire, overall sheathed with extruded PVC conforming to IS 1554, IEC 189 & BS 5308 shall be provided for Instrument/Equipment power supply.

Telemetrycabling

Telemetrycablingbetweenamasterstationandanoutstation,unlessotherwise specified,shallconsist ofaminimumof6signal pairs,ofwhichtwopairsshall be allocatedtothetelemetrysystem,onepair shall be allocated to a speech circuit and three pairs shall be spare. Each conductor shall be multi- stranded with an equivalent diameter of not less than 0.9mm. Conductors shall be laid up in star quad formation.Thedcresistanceofanypairofconductorsshallnotexceed88ohmsperloopmileat10°C and the difference between the resistances of the conductors of any pair shall not exceed 0.5% of the loop resistance of that pair.

Telemetrycablesshallbedesignedforburyinginwater-loggedground.

Conductorsshallbeplainannealedcopperwithaluminium/polythenelaminate sheathmoisturebarrier, copper or brass tape pest barrier, single galvanised steel wire armour and overall polythene sheath.
Thecableshallhaveasolidfillingofpetroleumjelly.

Thecharacteristicimpedance ofeach signal circuit shall have a nominal value of 600 ohms at 800Hz and the circuits shall be suitable for signal input levelsof between−30dbmto +4dbm(0dbm= 1mW intoa load of 600ohms). The overall attenuation between the terminations ofanycircuit at the mean frequency of the band width specified elsewhere shall not exceed 20dbm and the attenuation at any twofrequencieswithinthisbandwidthshallnotdifferbymorethan6dbm.Thetransmis

siontimefor any two frequencies withinthe band widthspecified elsewhere shall not differ bymore than 1 / (4% B) seconds, where B is the transmission speed in bauds, as specified elsewhere.

The signal-to-noise ratio within the bandwidth specified elsewhere shall be better than 12db. The frequencyofanyreceivedsignalshallnotdifferfromthefrequency ofthecorrespondingtransmitted frequency by more than 1% of the transmission speed in bauds specified elsewhere.

Loadingcoilsasnecessarytomeettheperformancerequirementsdetailedherein shallbesuppliedand installed at equally-spaced points.

(k) Fiberoptic cable

Tofacilitatetheproperandefficientco-ordinationoftheWorks theContractorshallsubletallCabling Works to one Sub-Contractor who has proven and successful experience in fiber optic cable installations on projects similar to the one now proposed.

IfcablesizesarenotindicatedonDrawingsorinschedules,determinethecorrectsizeb asedontotal end to end signal attenuation not to exceed 40 dB, including all splices and termination losses, and after taking into consideration.

a) Typeof fiber

b) Ambientconditions

c) Methodofinstallation

d) Thedispositionofeachcablerelativetoothers

Allcablesandwiresshallbesuitableforinstallationandcontinuousservicesintheambientco nditions described elsewhere in this document.

ShopDrawingsandProductDatashallbesubmittedfortheapprovaloftheEngineersasfollo ws;

- Submitfulltechnicaldetailsofeachtypeofcableproposed.

- Submitcopyoftestcertificatesfromthemanufactureroranindependenttestingauth orityconfirming that cables comply with the specification.

- SubmitexactrouteofthecablerunandrelevantSectionsintheshopdrawings.

Eachdrumlengthofcableshallbeallottedadistinctandseparatereferencenumbe r.Thisnumber shall appear onthetest certificate coveringtherespective length ofcable and shallalsobe clearly marked on the cable drum.

The Contractor shall advise the Engineer upon delivery to site of each drum length, quoting the referencenumber,thetestcertificatesshallbehandedtotheEngineerforexamination andapproval.

All cables shall be delivered to site with the manufacturer seals, labels or other proof of origin intact. Theselabelsandsealsshallnotberemoveduntilthecableisrequiredforuseandshallber etainedfor inspection by the Engineer.

The Contractor shall be responsible for the off-loading and handling of the cables on site, and shall ensurethatcablesaredeliveredtositeondrumsandproperlyprotectedagainstmecha nicaldamages. Where lengths are cut from cables, the open ends shall be sealed.

Thecontractorshallbeawareoftheneedtosupplyandinstallallcablesforthis Contract whichare most suitable for the special environmental conditions prevailing in this project.

The cable shall comprise 8 fibers, loose tube, two fibers per tube with central 1.5 mm nominal steel centralstrengthmember,moisterbarrier,steeltapearmoredincontinuoslengthsupto amaximumof 6.0kmorasdictatedbycablejointchamberlocationsandroutesurvey.

Single Mode	
Typeof fiber	Singlemode,dopedsilica
CoreDiameter	9.0±0.5micro m
CladdingDia	125±2.0micro m
Coating(outer) Diameter	250±15micromMaterialUVcurableacrylate
Numericalaperture	0.11microm
Attenuation	<0.4dB/km@1300 nm<0.2 dB/km@1500 nm
Bandwidth	1000 MHz@1300 nm

ChromaticDispersion	3.5ps/nmx km@1300 nm20 ps/nmx km@1500 nm
Operatingtemperaturerange	-30to+80deg.C
Crushresistance	>200N/cm
Weight	500kg/km(maximum)
Tensilestrength	2000 N(minimum)
Multi mode	
Typeof fiber	Multimode,doped silica
CoreDiameter	62.5±3.0micro m
CladdingDiameter	125±2.0micro m
Coating(outer)Dia	250±15micromMaterialUVcurableacrylate
Numericalaperture	0.275±0.15microm
Attenuation	<3.2dB/km@1300 nm<0.9 dB/km@1500 nm
Bandwidth	500 MHzxkm@1300 nm
Operatingtemperaturerange	-30to+80deg.C
Crushresistance	>200N/cm
Weight	500kg/km(maximum)
Tensilestrength	2000 N(minimum)

Cableterminationboxes

Cable termination boxes shall have double-ended screw terminals with removable links to facilitate coreisolationduringtesting.Eachboxshallcontainsufficient terminalsforeveryconductorplus20% spare terminals. Cable termination boxes shall have cable sealing chambers and insulated glands with earthing terminals so that the armouring may be earthed or isolated from earth, as circumstances dictate.

Termination boxes for use within buildings shall be of sheet steel with hinged or removable front covers. All other termination boxesshallbe caststeel or heavy gauge sheet steel construction giving protection to IP55. All termination boxes

shall be hot-dip galvanised or approved equivalent finish. Eachterminalboxshall havearemovable,un-drilledglandplateandtheContractorshallsupplyand fit the requisite number of cable glands.

At each cable termination box, each cable core (including spares) shall be identified by a numbered slip-overtypecollet.Thenumberingforaparticularcablecore shallbethesamethroughoutitslength.

Cablejointsshallbeat pointsapprovedbytheEngineer.

Each cablejoint shall be of the straight-through type. The conductors shall be ferrule-jointed with the insulation maintained by heat-shrink sleeving. Joint closure shall be made with epoxy resin and the completedjointshall be imperviousto water if submerged or in waterlogged ground. If castironjoint boxes be used, they shall be provided with cable glands and, after installation and testing, shall be covered with DensomasticHDcompound or equal;sothat all sharp corners, boltsand projectionsare mouldedtoasmoothsurface.TwolappingsofDensopolgradeZN 50mmtape,orequal,shallthenbe applied overall. Jointing shall be carried out on each conductor, including any provided in excess of the minimum quantity specified. All materials and things of every kind required for the cabling jointing shall be provided by the Contractor.

Cablelabelling

At each end of each cable, in a uniform and visible position, a label shall be fixed on the cable to indicatethesitecablenumberandroute,andthenumberandsizeofconductors.Labels shallbemade of brass, aluminium, lead or copper strip, engraved and retained by suitable non-rusting or non- corrodible binding wire passing through two fixing holes, one at either end of the label. If the cable gland is not normally visible, then the label shall be fixed inside the panel by means of screws.

Three-phasepowercablecoresshallbeidentifiedA,B,Corcolour-codedred,yellow,bluesothatthe correctthree-phasesequenceispreservedthroughoutthesystem.Single-phasepowercablecoresshall be colour-coded red and black.

Control cables shall have individual cores identified by means of suitable permanent ferrules bearing the same number at both ends. Core identification shall occur at every point of termination using an approvedsystemofcolour-codedferrulemarkers.Thesizeoftheseferrulemarkersshallbesuchasto match the overall diameter of conductor plus insulation. Numbering shall read from the termination upwards on all cores.

Eachcableandcoreshallbearthesamenumberatbothendsofthecableandcorerespectively.

(a) Powerterminations—colour,numberorletter.

(b) Controlterminations—letterornumberorboth.

Cableterminations

AllPVCSWAPVC,PVCPVCandXLPESWAPVCcablesshallbeterminatedwithmechanicalglands which shall complywith BS 6121.They shall seal the inner and outer cable sheaths against ingress of dirt and moisture and provide adequate mechanical support. Each cable gland shall be protected by corrosion-resistant molded PVC hoods, covering the entire assembly from the overall sheath to the gland neck.

Glandsforarmouredcablesshallprovideapositivearmourclamptotheenclosure sothatnotension is applied to the termination. The clamp shall also provide a high level of earth continuity and be of adequate size to withstand the full fault current of the system for one second.

Allglandsshallbeprovidedwithanearthingtag.Forcablesof4mm^2orless,a serratedwashermay be used instead for earth continuity.

Thecableterminationandsealingequipmentshallbeobtainedfromthecable manufacturer,orother approved supplier, and shall be purpose-made for the type, size and grade of cable concerned. The application of these materials shall be strictly in accordance with the manufacturer’s instructions.

Through joints shall be permitted only on long cable runs outside buildings. Where such joints are necessary;thecablesshallbejointedwithepoxyoracrylicresin Cold-settingcompoundwhichhas been pre-measured and pre-packed ready for use.

Theboxesshallbeofasplitmouldedplastictypewithfillingventsfor compound.

BondingstrapsshallbefittedwitharmourclampsacrossthejointandinspectedbytheEngineerprior to filling the box with compound. Wrapped pressure type joints shall not be accepted.

Conductorcoresshallbejointednumbertonumberorcolortocolor.

Cableinstallation-general

Cableswhicharetoberunonwalls,ceilingsorotherbuildingstructuresshall,

unlessotherwiseagreed by the Engineer, be secured on cable trays and ladders or enclosed in conduit or trunking.

Everycableshallbeneatlyrunverticallyorparalleltoadjacentwalls,beamsor otherstructural members. Cables shall not be installed in areas of direct sunlight.

Wherethisisunavoidable,approvedsunshieldsshallbesuppliedand installed.

Where the building structure incorporates purpose-built covered duct or trench systems for main cables,instrumentationcablesshallbesegregated andinstalledontrayworkorotherwisesecuredto the sides of the duct or trench.

Wherethestructureincorporatesgeneralserviceductsortrenchescontaining pipework,chemicallines and otherservices,all cablingshallbe segregatedfrom the other services andshallbe runon the walls unless otherwise agreed by the Engineer.

Cablesshallbespacedtopreventinterferencebetweenpowerandsignalcables, andtoavoid unnecessary crossovers.

The spacing of clips, saddles and cleats shall prevent the sagging of the cables during their installed life.Themethodoffixingclipsandthelikeshall bebymeans ofnon-corrodiblescrewsinsertedinto approved wall fixings, such as rawlplugs.

Cable hangers, cleats, saddles, brackets and similar supporting devices shall be of an approved type and of adequate strength for the cables they are supporting. They shall be treated to withstand Site conditions without corroding. Self-locking plastic buckle clips and strapping shall not be used. The arrangementandfixingofeachcableshallpermittheremovalandreplacementofanyc ablewithout disturbance to any other cable or the fixings thereof.

Whencablesareterminatedinanyparticularitemofequipment,specialcareshall betakentoensure that the cables finally approach the equipment from a common direction and are individually terminated in an orderly and symmetrical fashion.

SubmissionswhichtheContractorshallsubmitthefollowinginrelationtocable installationsin addition to submissions detailed elsewhere in the Specification.

Drawingsandschedules:

•Blockdiagramstoshowcontrolcablingsystemswitheachcableandtermin al equipment being identified as in the cable schedules.

•Cablerouteandlayoutdrawings.Forthoseitemswhichareunderground,th esedrawings shall include the following:

•Routeplansandsectionalviewsforallcableruns,cabletrays,cableduct s andcable trenches;

•Thepositionofallmarkerposts,joints,drawpitsandthelike.

•Cableschedulesshalldetailthecablenumber,type,voltage,size,routelength andnumberof cores or pairs. Control-cable schedules shall detail the connected and spare core numbers, diagram number for connected equipment, core ferrule and terminal reference number.

Dataandcalculations:

•Manufacturers'cataloguesanddatasheetsforallcablesandfittings; Cablesizing Calculations.

Testcertificates:

•Testcertificatesforallwitnessedandroutinetestscarriedoutatthe manufacturer'sworks and at Site (calibration).

Cabletraysand ladders

Cabletrayandcable-supportladdersshallbeofheavy-gauge galvanizedsteelandwithanoverall PVC coating when required to the approval of the Engineer.

Cabletrayandladdersystemsshallbeinstalledusingfactory-madesupports,joints andjunction/bend pieces. Wherever tray and ladder sections are cut and shaped on Site, cut edges shall be dressed and painted with at least two coats of cold galvanizing compound or lead-based anti-corrosive paint.

Laddersystemsshallbesecuredtowallsandceilingsbypre-formedgalvanizedinterlockingchannel.

Flexibleconduits

Flexible conduit shall be of the waterproof galvanized type of PVC wire-wound type with cadmium- plated mild steel couplings. Lengths of flexible conduit shall be sufficient to permit withdrawal, adjustmentormovementoftheequipmentto whichitisattachedandshallhaveaminimumlengthof 300mm. Flexible conduit shall not be used as a means of providing earth continuity. A single earth conductorofadequatesizeshallbeinstalledexternaltotheconduitcompletewithearth terminations.

Whereconversionfromrigidconduittoflexiblemetallicconduitistobemade,the rigidconduitshall terminate in a trough-type box. The flexible conduit shall extend from this box to the equipment; the earth continuitycable shall be secured tothe box and to the piece of equipment.The use of lidfacing screws and the like will not be permitted. Adaptors shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

PVC conduit

Wheregalvanizedconduitwouldbeliabletocorrosion,PVCconduitshallbeinstalled.

PVCconduitshallbeoftheovalorroundhighimpactnon-flame-propagatingtype asspecifiedand self-extinguishing, to BS EN 61386-21. Surface and concealed installations shall be generally as described for steel conduit.

PVCconduitfittingsshallcomplywithBS4607.Theyshallallbewhiteunless specifiedotherwise.

JointingshallbecarriedoutusingPVCsolventandsocketedaccessories.

Expansioncouplersshallbefittedinstraightsurfacerunsevery12m.Thefreeend shallbesealedwith non-setting mastic to form a waterproof seal.

Purpose-madebendsmaybeusedprovidingthatthecablebendingradiusis maintained.Crackedor crinkled conduit will be rejected.

The conduit shall be suitable for use in ambient temperatures of between −5°C and +60°C and shall notbeinstalledinareasthatreceivedirectsunlight.Aseparate protectiveconductor(earth-continuity conductor) shall be installed.

Adaptableboxesandaccessoriesshall be made fromheat-resistantinsulating material.The minimum wall thickness of boxes having a nominal internal depth of 16mm or less shall be1.5mm. For deeper boxes,theminimumwallthicknessshallbe2mm.Allboxeswhichareintendedtosuppor tluminaires or other heat sources shall have either external fixing lugs riveted to the metal inserts or utilize steel insert clips.

Cableinstallationmethods

General

Allcablinginstallationmethodsshallbesubjecttotheapprovaloftheengineer.

Installationdirectlyintothe ground

Wherecablesareburiedintheearth,thebottomoftheexcavatedtrenchesshallbe freedofsharp stones and other projections and covered with sand to a depth of 50mm.

Cablesshallbeunrolledfromdrumswithoutloopsandkinks,andcareshallbe takenwhenlayingto avoid damage to the outer sheath by drawing over sharp projections.

Cables shall be snaked into the trenches to avoid tension in the cables during backfilling or from subsequent settlement. After laying, cables shall be covered to a minimum depth of 100mm of compactedsandandshallhavealayerofprotective interlockingconcretecabletiles.Thetilesshallbe overlaid with marker tape.

Whencablesofdifferentvoltagesarelaidtogetheratthesamedepth,verticalcable tilesshallbeused to segregate the cables.

ICAandcommunicationcablesshallbelaidnotcloserthan1000mmtohighvoltage cables.

Asufficientnumberofrollersshallbeprovidedsothatthecabledoesnottouchthe groundortwist during pulling.

Installationinunderground ducts

Underground ducts shall be constructed of impact-resistant uPVC and laid at a minimum depth of 500mm (to the duct centre), surrounded by at least 75mm of sieved sand. At road crossings, uPVC ductsofminimumdiameter100mmshallbelaidataminimumdepthof1000mm(tothed uctcentre). The ducts shall be encased by 150mm concrete on all sides.

Wheninstallingcablesinducts,thefollowingmeasuresshallbe observed:

- Cablesshallbepulledinastraightline;
- Rollersshallbepositionedattheedgesofdrawpitsbothatthedrawing-inanddrawing-out points over which the cables shall be drawn;
- uPVCpipesandcablesheathsshallbecoatedwithanapprovedlubricant;
- Sufficientdraw-inpointsshallbeprovidedandadequateroomallowedfor installationof cables;
- Thepullingropeshall beguidedbyrollers.

Onlyonepowercableshallbedrawnintoeachduct.

Wheneveraductislaidintheground,adraw-wireshallbepulledthroughwithatleast1000mm excess at each end and the draw-wire left in position if the duct is not to be used immediately.

Sealingcableentriesintobuildings

Whenevercablespassthroughwallsbelowgroundlevel,thepointofentryshallbe sealedagainstthe ingress of water. This shall be achieved with silicone foam or similar.

Allcableentriesintoabuildingshallbeinductsandwherethecablespassinorout ofducts,together with any spare ducts, the ducts shall be sealed against the ingress of moisture by means of duct stoppers and bituminous compounds or by any other method approved by the Engineer. The stopper shall have a fire resistance of at least 30 minutes.

Markingofunderground cables

Thelocationofallundergroundcablesshallbeidentifiedby:

- Brassplatesfixedtotheexteriorsurfaceofallwallsofbuildings300mmabovegrou ndleveland directly above the point where cables pass through the wall;
- Markerpostsinroadvergesandthelikeatintervalsofnotmorethan100mandatallju nctionsand changes of direction along the route;
- Markerpostsat10mintervalswithinanenclosedsiteandatalljunctionsand changesofdirection along the route.

Markerpostsshallbeofconcrete, notlessthan200mmhighabove groundwithan inscribedbrassor enamel metal plate. The inscription shall indicate the presence of a cable below, the depth, classification and voltage rating.

Adrawingorsampleofatypicalmarkerpostshallbesubmittedfortheapprovalofthe Engineer.

Installationincabletrunking

Cable trunking shall be manufactured from mild steel of not less than 1.25mm and shall be hot-dip galvanized. The Contractor shall ensure that the size of the trunking is adequate for the number of cablestobeinstalledtogetherwith50% sparecapacity.Trunkingshallhaveminimumdimensionsof 50mm % 50mm.

Segregation of cables shall be carried out if required using continuous sheet steel barriers with the bottomedgeweldedtothetrunking.Thetrunkingshallhavetworeturnflangesforrigidi ty.Additional strengtheningstraps shall be fitted internallywherever necessary. The cover shall overlap the trunking and be made ofthe same gauge. Fixingscrewsforcovers shall berecessed and beof the self-retaining quick-fix type. All bends, tees and intersections shall be of the gusset type and shall, wherever possible, be purpose-made by the manufacturer and of a matching design to the main trunking.

Cables shall be retained in the trunking when the cover is removed by means of straps. Internal connectingsleevesshallbefittedacrossjointsinthetrunkingand earthcontinuityensuredbybonding each section of trunking to a continuous earth wire.

Non-flammablefirebarriersshallbeinsertedwherethetrunkingpassesthroughwallsorfloors. Conduit connections to trunking shall be made by flanged couplings and male bushes.

Trunkingshallbesupportedatintervalsnotgreaterthan2mhorizontallyor2.5mvertically.

Crossingsoverexpansionjointsshallbemadeinflexibleconduit.

Shoulditbenecessarytocutordrillasectionoftrunking,thebaredendsshall immediatelybegivena coat of zinc-rich cold galvanizing paint.

CableandtrunkingrunsshallbedeterminedbytheContractorandagreedbytheEngineerbeforeany work is started. The run shall be at least 150mm clear of plumbing and mechanical services.

Trunkingsystemserectedoutsideabuildingshallbe weatherproof.

Installationintroughsandtrenches

Where the building structure incorporates purpose-built covered trench systems, power distribution cablesmaybelaidonthefloorofthetrench.Controland instrumentationcablesshallbesegregated and installed on supporting steelwork or cable trays secured to the walls of the trench.

Where the building structure incorporates general service trenches containing pipe work, chemical lines and other services, all cabling shall be segregated from other services and run on the trench walls.Crossoversshallbekepttoaminimumandcablingshallbetakenabovewetservicepipework.

Cable trays shall be of perforated steel with formed flanges and of minimum thickness not less than 1mmfortraysupto100mmwidth,notlessthan1.25mmfor

traysfrom100mm to150mmwidthand not less than 1.5mm thickness for trays from 150mm to 300mm width.

Cable-tray supports shall be of sufficient strength to maintain rigid support to the fully-laden cable trayalongitsentirelength.All bracketsandtrayworkshall be suitableforwithstandingatemporary weight of 125kg.

Whereverpossible,cabletraysshallbeinstalledinfulllengthswithoutcutting.

Should it be necessary to cut or drill a length of tray, the bared ends shall be dressed and immediately begivenacoatofzinc-richcoldgalvanizingpaint.Similarlyfor PVC-coatedtrays,thebaredendshall be immediately sprayed using a PVC aerosol.

Allcablesshallbefirmlysecuredtothetrayusingpurpose-madesaddles,asapprovedbythe Engineer, together with proprietary cable cleats.

Installationinbuildings

Cablesrequiredtoberunonwalls,ceilings,orotherstructuresshallbecarriedon substantialcleats, eitheringroupsorsimplyat spacingdeterminedbyrating requirements,supportedontrayorladder racks or enclosed in conduit or trunking.

Allcablesshallbeneatlyrunverticallyorparalleltoadjacentwalls,beamsorother structural members.

The spacing of clips, saddles and cleats shall be such as to prevent the sagging of the cables during theirinstalledlife.Themethodoffixingclipsandthelikeshall bebymeansof non-corrodiblescrews inserted into approved wall fixings.

Cablehangers,cleats,saddles,bracketsandsimilarsupportingdevicesshallbeof anapprovedtype and of adequate strength for the cables they are supporting. They shall be treated to withstand site conditions without corroding. Self-locking plastic buckle clips and strapping shall not be used.

HangersshallbespacedaccordingtorecommendationsintheIEEWiring Regulations.Allowance shall be made for expansion and contraction of the cables.

Cablesshallbelocatedbetween50mmpegsspacedat40mmcentersacrossarung sothata40mmor 80mm space is maintained between cable centers. Cleats shall be used where the ladder racking is vertical.

Cablesshallberunatleast150mmclearofplumbingandbelowheatingandhotwaterpipework.

Cableinstallation in conduits

Conduitsshallbeeithergalvanizedheavy-gaugesteelscrewedtypeorlight-gauge steelnon-screwed type, steel or PVC. Accessories shall either be malleable cast iron or pressed steel.

Aspacefactorof40%shallnot beexceededand,inanycase,conduit shall haveaminimumdiameter of 20mm. The tubingis tobe perfectlysmooth inside and out and free fromimperfections. Bothends of every length of tubing shall be reamed and all sharp edges removed before erection.

Whereconduitsconverge,adaptorboxesshallbeused.Conduitsshallbe connectedbymeansofmale brass bushes and couplings. Where conduits are greater than 25mm diameter, straight-through joint boxes shall be of the trough type. Where conduit or fittings are attached to equipment casings, the material of the casing shall be tapped for a depth of not less than 10mm or male bushes and flanged couplings may be used.

Hexagonal lock nuts shall be used at running joints. They shall seat firmly and evenly on to mating faces.Allfunctionboxes,draw-inboxes,andinspectionfittingsshallbeplacedsothatthecablescan be inspected, withdrawn and re-wired during the life of the installation.

Generallynot more thantwo bendsor offsets or onecouplingwill be permitted without a suitable inspection accessory. Fish wires shall not be left in conduits during erection. The whole of the installationshall bearrangedforaloop-intypeofsystemwithjointsbeingcarriedoutatswitches, isolators or appliance fittings.

Endsofconduitswhichareliabletobeleftopenforanylengthoftimeduring buildingoperations shall be plugged to prevent the ingress of dirt and covers shall be fitted on all boxes.

Generally,conduitsshallnotcrossexpansionjointsofbuildings.Wherethey cannotbeinstalledin anyother manner, a galvanized flexible conduit shall be used acrosstheexpansionjoint. Atotal of 150mm movement shall be allowed.

ProcessInstrumentation

General

Instrumentation system shall be designed, manufactured, installed and tested to ensure the high standardsofoperationalreliability.Allelectroniccomponentsshallbeadequatelyrated andcircuits shall be designed so that change of component characteristics shall not affect plant operation.

Allinstrumentationequipmentshallbenew,ofprovendesign,reputedmake,andshallbesuitablefor continuous operation.Unless otherwise specified, all instruments shall be tropicalised.The outdoor equipments shall be designed to withstand tropical rain. Wherever necessary space heaters, dust and water proof cabinets shall be provided.Instruments offered shall be complete with all the necessary mounting accessories.

Electronicinstrumentsshallutilisesolidstateelectroniccomponents,integratedcircuits, microprocessors, etc., and shall be of proven design.

Nocustommadehybridtypeintegratedcircuitsshallbeused.

Unlessotherwisestated,overallaccuracyofallmeasurementsystemsshallbe±1%ofmeasuredvalue, and repeatability shall be ±0.5%.

Unlessotherwisespecified,thenormalworkingrangeofallindicatinginstrumentsshallbebetween 30% and 80% of the full scale range.

Onresumptionofthesupplyfollowingapowerfailuretheinstrumentsandassociatedequipmentshall start working automatically.

Theinstrumentsshallbedesignedtopermitmaximuminterchangeabilityofpartsandeaseofaccess during inspection and maintenance.

Unlessotherwisestated,fieldmountedelectricalandelectronicinstrumentsshallbeweatherproofto IP-65.

The instruments shall be designed to work at the ambient conditions of temperature, humidity, and chlorine contamination that may prevail but in any case not less stringent than those conditions detailedintheProjectRequirements.Instrumentsshallberesistanttocorrosioninthe atmospherein which they are expected to operate.

Lockableenclosuresshallbeprovidedforallthefieldmounted instruments.

All field instruments, and cabinets/panel mounted instruments shall have tag plates/name plates permanentlyattachedtothem.Detailsofproposedinscriptionsshallbesubmittedtoth eEmployerfor approval before any labels are manufactured.

Allcoatedpartsofsensorsshallbemadeoutofnoncorrosivematerialcapableofwor kingwith chlorine content of 5 ppm.

For allinstrumentsinstalled inthefield,surge protection devices (SPD s) shall beprovidedat both endsoftheconnectingcableforprotectionagainststaticdischarges/lightningandel ectromagnetic interference.

Individualpairscreened,overallscreened,armouredcablesshallbeusedforanalogue signalsand armoured, and overall screened cable shall be used for digital signal cables.

FlowMeasuring Systems

Flowmeasuringsystemshallconsistofflowsensor/ transducers,flowcomputerandflowtransmitter.

Flowtransducersshallberuggedinconstructionandshallbesuitableforcontinuousop eration.Flow transducers shall have waterproof construction and shall be suitable for installation in underground/above ground pipelines.

Toavoidtheeffectsofdisturbancesinthevelocityprofile,astraightanduninterruptedr un,upstream as well as downstream from the location of the flow sensor shall

be provided in accordance with the requirements of the flowmeter manufacturer.

The flow transmitter shall be suitable for field or panel mounting and shall accept an input from the flowsensor.Itshallprocesstheinputsignalandprovide4-20 mAdcoutputproportionaltoflowrate. The flow range shall be adjustable.

Azerospanadjustmentfacilityshallbeprovidedforflowtransmitterandindicator.

Flow measurement shall not be affected by physical properties of sewage viz., temperature, pressure, viscosity,densityetc.,withingivenlimits.Contractorshallprovidecompensatingelectroniccircuitsif required. The overall accuracy of flow measuring systems shall be at least ±1.0 % of the measured value unless otherwise stated.

(a)ElectromagneticFlowMeter(FullBore):

General

The Electromagnetic Flow Meters shall be installed in RCC chambers / open pits or buried for indicationofflowrateandtotal consumptionofwaterinatransmissionordistributionpipeworkof water supply system.

TheElectromagneticFlowMetersshallwithstandmaximumworkingtemperatureand working pressure shall be as per process requirement.

ElectromagneticFlowMeter

Fullboreelectromagneticflowmetersshallbedesigned,manufacturedandcalibrated toISOstandard. The flow meter shall be capable of measuring bi-directional flow.

GeneralSpecification

Electromagnetic Flow Meter shall be a velocity sensing electromagnetic type, microprocessor based signal converter, Flow Integrator and Totalizer sealed housing, flanged tube meter as per working pressurerequirement.Themetershallbemanufacturedtohigheststandardavailablefor mag-meters.

The accuracy shall be inclusive of linearity, hysteresis, and repeatability, temperature and pressure effects.Themeterassemblyshalloperatewithinarangeof0.3m/secto5m/secandpressurerating shall be as per process requirement to be constructed as follows

Metertubeshallhaveaconstantnominalinsidediameterofferingnoobstructiontotheflow.

SignalConvertershallbepulsedDCcoilexcitationtypewithautozeroing.Thesignalconvertershall be remotely mounted away from the meter.

Theconvertershallindicatedirectionofflowandprovideaflowrateindication andatotalofflow volume for both forward and reverse directions.

Theconvertershallprovideanisolated4-20 mAoutput intominimum600ohmloadandafrequency output of a maximum of 0-10 KHZ and a scaled pulse output.

Themicroprocessorbasedsignal convertershallhaveaself-diagnostictestmodeandbacklitdisplay that continuously displays ‘Rate of Flow’ and ‘Total Volume’.

TheconvertershallbecompatiblewithMicrosoftWindowsandothersoftwareprogramswithbuiltin terminal communication capabilities of RS 485, HART or other protocols for interface.

Theconvertershallberemotelymountedmaximumupto200mfromthesensor,andshall besupplied with all calibration complete for desired requirements.

Theconvertercumtransmittershallbefullyprogrammablefromthefrontfacia.

Theprogrammingshallbeuserfriendly,self-promptingmenudriven.

Thelength ofthesensor shallbe strictlyas per ISOupto DN600 mmand forother sizesitshallbe as perthemanufacturer’sstandard.Only,onemanufacturershallmakeallmetersizeand stylesrequired for this contract.

LevelMeasuring System

(i) RadarTypeLevelTransmitter

RadarTypeLevelTransmitterappliedforlevelmeasurementshallcompriseatransducer,controlunit and remote indicator.

The transducer shall be suitable for flange or bracket mounting as required and shall be environmentallyprotectedtoIP65.Itshallhaveambienttemperaturecompensation,adjustabledatum setting facilities.

TheaccuracyofthesensorshallbeBetterthan+/-5mm.

Itshallbeprogrammablewithanintegralprogrammingkeyboardandprovideadigitaldisplayofthe measured variable.It shallbe provided with diagnosisfacilitiesandshall providean isolated4 to20 mA dc output signal proportional to the range of measurement.

The design and application of Radar type level transmitters shall take into account the vessel or channelconstruction,thematerial,size,shape,environment,processfluidormaterial,thepresenceof foam, granules, size etc.

The installation shall avoid any degradation of performance from spurious reflections, absorption, soundvelocityvariations,sensordetectionarea,temperaturefluctuations,specificgravitychangesand condensation.For applications where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection.

Ifturbulenceexists,shielding,stillingtubesorothermeasuresshallbeprovidedtoavoideffectsonthe measurement.

(ii) ConductivityLevelSwitches

Theelectrodesusedforconductivitylevelswitchesshallbestainlesssteel.Singleelectrodesystems (one electrode per holder) shall be used (except where their use is impractical) with insulated electrodes such that only the tip of each electrode is exposed to the liquid at the operating level.

Relayorcontrolunitsoperatingwithlevelelectrodesshallhaveadjustablesensitivity.Electrodesfor use in fluids of low or variable conductivity shall be fitted with conductivity discs.

Whererelayorcontrolunitsarenotmountedincontrolpanels,theyshallbeprovidedwithsurface mountingenclosures with a degree of protectionto IP 52 for indoor locations or IP 65 for outdoor locations.

Pressuregaugesandtransmitters

PressuregaugesshallcomplywithBSEN837-1orequivalentandhaveconcentric scales.Forspecial arduous duty where the gauge is subject to pressure pulsations and/or vibration, it shall be provided with a glycerine-filled dial and line snubbers shall be used. Bourdon-tube type differential-pressure gauges shall be capable of withstanding full line pressure on any side with the other side vented to atmosphere without damage to or effect on the calibration. No plastic material shall be used in their construction. Internal partsshall beofstainless steel, bronze orapproved corrosion-resistant material.

Theminimumdiameterforroundpressuregaugesshallbe150mmunlessspecified otherwiseorwhere the gauge forms part of a standard item of equipment.

Unlessspecifiedelsewheretheaccuracyforpressuregaugesshallbe1%ofrange, fordiaphragm gauges 1% of range and for differential gauges 1.5% of range or better.

Where compensation of more than 2% of the instrument span is needed for the difference in level betweentheinstrumentandthetappingpoint,thereadingshall besuitablyadjustedandtheamountof compensation shall be marked on the dial.

Thezeroandspanofapressuretransmittershallnotchangebymorethan0.1%of thespanperCelsius degree change in ambient temperature. After application for 10 minutes of pressure at 130% of maximum pressure, the change in zero and span shall not exceed 0.1% of the span.

Pressure transmitters shall have an accuracy typically better than 0.1% of span, depending on the applicationandshallbeprotectedtoBSEN60529:IP65 standardorhigherstandard.Fortransmitters installed in meter chambers liable to flooding or underwater applications, they shall be to BS EN 60529: IP 68 standard and shall operate up to maximum submergence of 20 metres of water.

Pressuretransmittersshallprovideadigitalor4mAto20mAdcoutputproportional tothepressure range.

Pressuregaugesandtransmittersshallhaveprimaryisolatingvalves,2or3way valvemanifoldand vents, in such a way that it has the facility to calibrate the gauges or transmitters without removal.

Strain-gaugepressuretransducersand transmitters

Strain-gaugepressuretransducersshallusethinfilmsensorswithoutbonding.

Each instrument housing shall be of all-welded Grade X 4 CrNiMo 17 12 2 stainless steel orequivalent and hermetically sealed. Non-interacting, zero and span adjustments shall be provided on eachtransducer.Themeasuringdiaphragmshallbeisolatedfromtheprocessfluidbya non-corrodible barrier diaphragm. The mean time between failures for any model of strain-gauge transducer shall be not less than 15 years, and the performance of the measurement system shall be as given below or higher performance:

- Accuracy:±0.1%ofcalibratedspan,includinglinearity,hysteresisandrepeatability;
- Repeatability:±0.05%atmaximumspan;
- Stability:±0.1%ofupperrangelimitover6−monthperiod;
- Over-pressure:sustaina400%over-pressurewithoutdamage;
- RFI/EMIeffect:lessthan1%ofspanwith500MHzat5Wdirect contact;
- Power-supplyvariationeffect:0.01%pervolt variation.
- Loadvariationeffect:±0.0002%perohmofloop-resistancevariation.
- Temperature:−29°Cto+82°Crange;totalthermalerrorof ±0.75%ofspanover0°Cto50°C;
- Protection:IP65.

Strain-gauge transducers which do not have terminals for their cable connection, shall have integral sealed-

cableassemblies,installedinconduitandterminatedat
weatherproofjunctionboxes,protected

toIP65eachmountedneartoitsassociated processtransmitter.Adigitalor4mAto20mAdcoutput signal proportional to the transducer range shall be provided.

Strain-gaugepressuretransmittersshallbegenerallyasthetransducerexceptthatit shallincorporatea waterproof pressure transmitter producing a digital or 4mA to 20mA output signal.

Provisionfortransducerventingshallbe provided.

SurgeProtection Devices

Surge protection devices (SPDs) shall besuitablefor withstandingthe surge arisingout of high energy static discharge / lightning strikes and protect the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semiconductors like Tranzorb, zener diodes,varistorsandanautomaticdisconnectandresetcircuit.SPDsshallbepassivean dshallrequire negligible power for operation.During the occurrence of a surge it shall clamp on the allowable voltage and pass the excess voltage to the ground.The SPD shall be self resetting to minimise the down time of the measurement loop.

SPDsshallbeprovidedtoprotectdevicestransmittingandreceivinganalogueanddigit alsignals derived from field devices located outdoors.

Thesurgeprotectiondeviceshallberatedforsurgeratingof10KA.

ProgrammableLogicControllers

General

Programmable Logic Controllers (PLC) shall be provided as a Standalone Controller to perform combinationalandsequentiallogicfunctions,statusmonitoringandreportingfunctio nswithcounter and timer facilities.

PLC shall comprise of necessary processors, Simplex input/output (I/O) modules, communication interfacemodulesandHuman-MachineInterface(HMI)requiredperformingthedesiredfunctions.

PLCshallhavethefollowingattributesasaStandaloneController.

- carryoutsequentiallogicimplementationforoperationsof plant;
- carryoutcomputationandinterfacingfordataacquisition,datastorageandretrieval;
- itshallacceptdownloadedprogramfroma programmer;
- itshallhavedifferentfunctionalmodulestoperformthedesiredfunctions;
- itshallscantheinputsintimecyclesandupdatethestatusofitsoutputs.

ThePLCsystemshallbeexpandable,OPCCompatibleandshallbemodularinconstruction,soasto be capable of future expansion without hardware modifications.

PLCsshallbemicroprocessorbased.PLCsshallusestandardknownprotocolsandstructuresfor communication outside the system.

Incaseofsystemfailureorpowersupplyfailuretheoutputsshallattainapredetermined failsafe condition (this shall normally be ‘off’).

ThePLCusedshallhaveaprovenrecordinthetypeofapplicationconcernedandintheprevailing environmental conditions.

PLCshallbeofanapprovedtypefroma majorinternationalmanufacturer.

PLCSystem(Panel)shouldbehousedinadustfreeenvironment.

PLCCoding

TheContractorshallsupply,install,programandcommissionthePLCusingthePLCmanufacturers recommended windows based PLC coding and documentation software.The PLC code shall be structured in the manner of the best industry standard and have comprehensive subroutine and rung annotation. PLC shall be coded using FBD language.

TheContractorshallprovideasuitablePCcompletewithPLCcodinganddocumentationsoftwareas specified in the bid document & as agreed with the Employer representative based on the FDS submitted.

IndustrialSCADA/HMI

General

TheSCADA/HumanMachineInterfaceshallbesuitablefordaytodayoperationbynon-computer literate personnel in the monitoring and operation of the treatment works.

SCADA/HMI

The SCADA / HMIsystem shall provide efficient and safe operationof the process plant bydetecting alarm and error conditions, alerting the operator to these conditions both visually and audibly, monitoring and controlling all important system parameters and providing facilities for plant optimisation.Thesystemwillallowoperators,techniciansandengineerstoissuecommandstochange system parameters, start and stop equipment, provide configuration tools and operate diagnostic facilities from HMI and Engineers workstation (EW), after successful log-on by security password.

TheSystemshallperformallthenecessaryfunctionsfortheoptimummonitoring,controland operation of the entire system.

TheHMIshallbeconstructedtoahighstandardtoprovideahighprofilefeatureandfocalpointfor visitors to the ISPS's.

UninterruptiblePowerSupply(UPS)

The power for Programmable Logic Controllers (PLC), SCADA / HMI, Engineering Workstation (EW)andOnlineFieldInstruments shallbederivedfromUPS.Thisshallalsoincludecorresponding managed Ethernet switches, internal and external communication systems, Wireless communication Systems.

TheUPSprovidedshallbesizedtoprovidesufficientpowertomaintainsystemfunctioningfora period of minimum **1 hour,** in case of power failure.

TheabovefeatureshouldbedemonstratedduringFactoryAcceptanceTest(FAT)&SiteAcceptance Test (SAT).

ENDofPART-7

Part-8Deleted

PART9

GENERALPAINTINGANDPROTECTION REQUIREMENTS

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PART 9

GENERALPAINTINGANDPROTECTION REQUIREMENTS

General

Thepreparation,applicationandconditionsforworkshallcomplywiththerecommendationsofBS 5493 and BS 6150 or if the protection is of a special nature, in accordance with the manufacturer's directions.

Paints, primers and undercoats shall be obtained from the same manufacturer and except where a definitetimeisspecifiedbetweenmixingandapplication,shallbereadymixedforuse.Theyshallbe compatible with one another.

Paintsshallbedeliveredinsealedcontainersbearingthemanufacturer'sname,batchnumber,etc.and shall carry a label giving details of quality and instructions for use.

No site painting shall be carried out unless the surface to be painted is dry, the air temperature above 4ºCandtherelativehumiditylessthan85%.TheEngineershallapprovethemethodsforremovingall dirt, oil, grease, etc, before Site painting commences.

Test platescarryingfinishesfromtheactual coatingusedmayberequiredbytheEngineerfor inspection and test purposes.

Tofacilitateinspection,noconsecutivecoatsofpaintshallbeofthesameshadeexceptinthecaseof white.

Primingtotwomatingsurfacesshallbeappliedpriorto assembly.

All items of Plant shall be delivered to Site with the shop paint finish applied unless specified otherwise.Afurthercoatoffinalfinishpaintshallbeappliedat Site,ofsufficientthicknes stoproduce a uniform colour and appearance. Such painting shall be carried out within one month of successful acceptance trials for the Plant.

Allpaintthicknessesshallbecheckedusinganalkometerorequivalentinstrument,supplied bythe Contractor, for each layer of paint, to the reasonable satisfaction of the Engineer.

ColourCodingandLabelling of Pipesand Equipment

Allpipesandequipmentshallbecolourcodedtoascheduletobeagreedwiththe Engine erbeforeany site painting starts, or earlier if necessary to suit manufacturing procedures. Valves and fittings shall be painted in the same colour as the pipe of which they form a part. Where a pipe enters or leaves a piece of equipment the pipe colour shall extend up to but not including the flange attached to the equipment.

All pipelinesshall beidentifiedbystick-on90micronthickvinyl filmlabelsshowingthenameofthe material to be carried by the pipeline and an arrow indicating the direction of flow. Letters of titles shall be pre-spaced on carrier tape and the complete title protected by one piece removable liners. Titles shall be at intervals not less than 8 m, but shall in any case be provided in every space through whichthepipepasses.Locationsoflabelsshallbesubjecttopriorapproval bytheEngine er.Lettering sizes shall be between 16 mm and 75 mm in height depending on the size of the pipe.

Pipessmallerthan22mmoutsidediametershallbelabelledbytheuseoftagsinsteadofla bels.Tags shall be made of brass no smaller than 65 mm x 16 mm by 1.5 mm thick, with lettering etched and filled with black enamel.

Titlesshallalsobeprovidedonallequipmentinlocationsandinsizestobeapproved bytheEng ineer.

CleaningandPreparingatPlaceof Manufacture

TheContractorshall beresponsibleforthecleaningandpreparationforpainting,primingorother wise protectingas specified of all parts of thePlantat the place of manufacture prior to packing.

(a) Cleaning

Partsshallbecleanedpriortotestingatthemanufacturer'sworks.Partssubjectt ohydraulic test shall be tested before any surface treatment. After test all surfaces shall be thoroughly

cleanedanddriedoutifnecessarybywashingwithanapproveddewateringfluid priorto surface treatment.

(b) Preparation

Bright parts:Bright parts and bearing surfacesshall be thoroughly polished and protected fromcorrosionbytheapplicationofrustpreventivelacquerorhighmelting-pointgrease, as approvedbytheEngineer, before the parts are packed.A sufficient quantityof the correctsolventfor removaloftheprotective compoundsshallbesuppliedandpacked witheach particular part.

Embeddedparts:Embedded parts or those partsofan assemblywhich will be embedded in concreteshallbe thoroughlydescaled and cleaned to the satisfaction of the Engineerandbefore beingpackedshallbeprotectedbyacement washorotherapprovedmethod.Nocastironor steel work shall bebitumenortar coatedwhereit is to be cast into theconcreteand provision shall be made for cleaning off anyportions so coated.

Gritorshotblastedparts: Grit orshot blastingshall becarriedout inaccordancewithB.S.7079toa standardbetween `First Quality' and `SecondQuality' givenin Table 1 after which the maximum amplitudeof the surface shall not exceed 0.1 mm.

CastIronandSteelpipework:Allungalvanisedsteelpipeworkincludingpumpsuspens ionmains, bearing spidersand tunnel tubes shall be preparedinternally andexternally by grit or shot blasting asspecified above and the surfaces primed as specified withinfour hours of blasting.

PaintingandFinishingatPlaceofManufacture

ThisClausegoverns the methodsfortheprotective coatingsto be applied to structural steel, metalwork andironworkas corrosionprotectionsystems.The systems designed as specified here shall be applied as specifiedunder ProtectiveCoatings.

Protectivecoatingspecifiedelsewherefor particular workssuch aspipesand cladding shall firstlybedesignedin accordancewith particularrequirementsspecifiedelsewhereandsecondlyinaccordancewithanyrequ irements herein which are not overridden elsewhere.This specification makes reference to the following standard.

B.S.5493"codeofpracticefortheprotectivecoatingofironandsteelagainstcorrosion"

The Contractor shall design each protective coating systemand shall submit details of each systemto theEngineerforapproval.Submissionsshallwherepossiblebeintheformatofwhiche xamples aregiven attheendofthissectionwithsuchadditional informationand samples as the Contractor mayprovide or the Engineer may require to enable the system tobe assessed.

Protective coatingshall bedesignedin accordance with B.S. 5493 or equivalentto have a longlife, generally of at least 10 years to first maintenance.Protection systems shall be chosen to be easily maintainedinthefutureandtoallownon-specialiston-sitere-coatingwherenecessaryusingsingle part paints.

ForthepurposesofsystemdesignthegeneralenvironmentshallbeasspecifiedinB.S.5493Table 3 Part 2 `Exterior exposed polluted inland'. Bulkhead gates and stoplogs shall be assumed to be exposed to a Table 3 Part 8 `Non-saline water' environment unless otherwise approved by the Engineer.

Interior spaces shall be considered to be dry in administration areas open to continuous access and damporimmersedinotherspaces.Theprotectivecoatingofcomponentsorstructures whichare continuouslyor infrequentlyimmersed shall be designed forthemore onerousofthesetwo conditionsrelevanttothe protection system used.

Allexteriorexposeditemstobecoatedshallhaveafinalcoatofgoodappearanceofacolo urandtype as approved by the Engineer.

Protectivecoatingsystemsshallgenerallyfallintooneofthefollowingbasicsystems;

- galvanising;
- galvanisingpluspainting;
- multi-coatpainting;
- Bitumenenamel;
- OthersasproposedbytheContractorandapprovedbythe Engineer.

The Contractor shall submit to the Engineer details of his proposals for the corrosion protection of eachoftheitemsrequiringsuchprotection,whichwillgenerallyfallintotheabovecate goriesas follows:

- trashscreens, flooring, ladders,accesscovers and frames, step irons and other components which are inaccessible but subject to abrasion/damage;
- structuralsteelwork (including cranebeams,monorails,cranestructuresandchassis),bulkhead gates, stoplogs, grappling beams, steel tanks and otherlargeitemsreadilyaccessiblefor maintenance;
- valvesandothercorrosion-susceptible itemswhich maybeburiedandarenotcoveredby the provisions of other specifications :
- othercomponentsnot covered bytheabovefor which the contractor may propose a system which he considers to be more suitable for the duty;
- electricalswitchgear,transformers,controlpanelsetc.

Allpaintingmaterialshallbeappliedinstrictaccordancewiththepaintmanufacturer'sinstructions.

(a) Plantsuppliedtositewithfinalcoatingapplied:

Cubicles,cabinetsetc.otherthanthosespecifiedinPart10ofSection4.

Beforeanysteel work is painted thesteelmustbe thoroughly cleaned and an approved anti-rusting priming coatappliedso that the possibilityofrustingor corrosiontakingplace is negligible. All surfaces should have not less than two stoved undercoats and two top coats or air drying paint. The undercoats shall be easilydistinguishable in shade or colour formthe primingand finishingcoats. The two final coats shall be in a colour and finish to be advised by the Engineer. Theinsidesurfacesof anycubicles,cabinetsetc.wherecondensationisliabletooccur,shall becoatedwithanapproved anti-condensationcomposition.TheContractorshallensurethatallcomponentsectionsofa switch boardwherever manufactured shall have a finish of uniform texture and an exact colour match.

Chromiumplatedparts:Wherechromiumplatingisspecifiedorofferedbythemanufacturerit shall comply with the requirements of BS EN ISO 1456 including the followingprovisions.No blisteringofanysurfaceswillbetolerated.Thefinishedappearanceshallbebrought.Wherethebase metal issteel,platingshallbe applied in accordance withTable 2. Other base metals shall beplatedin accordancewithTables3,4,5asappropriate.Forallbasemetalstheserviceconditionnumber 2shall be used.

Smallborepipes,valvesandfittingsetc.,whicharesitedinarchitecturallyfinishedareasofthestation and selected by the Engineer shall be chromium plated.Damage to chromium plating shall be made good before taking over.

Galvanised parts:All materials to be galvanised shall

beofthefulldimensionsshownonthe approveddrawingsorspecifiedandallpunching,cutting,drilling,screwtappingandtheremoval of burrsshall becompletedbefore the galvanisingprocessbegins.Parts to be galvanised shall be shot blasted as specified above.Such parts shall be galvanised not more thanfour hours after commencement of shot blasting.

Allgalvanisingshallbedonebythehotdip-process.Noalternativeprocessmaybeusedwithoutthe approval of the Engineer.No components shall be galvanised which are likely to come into subsequent contact with oil.

Thezinccoatingshall beuniform,cleansmoothandasfreefromspangleaspossible.Inthecaseof component parts thezinccoatingshall weighnot lessthat 610g/sq.mofareacoveredandshall not be less than 0.090 mm in thickness.

Boltsandnutsshallbesherardised.TheEngineermayselectfortestasmanycomponent stobe weighed after pickling, and before and after galvanizing as he may think fit.

All galvanised parts shall be protected from injuryto thezinccoatingdue todifferentialserration andabrasionduringtheperiodsoftransit,storageanderection.Damagedareasofthec oatingshall be touched up with an approved zinc-dust paint or other approved flake metallic compound.

Castironandsteelpipework:(Internalsurfaces)

Theinternalsurfacesshallhaveanapproved coating.

Whereabitumenbasedcoatingisused,itshall beinaccordancewithType2ofBSEN 10300.

Prior to lining, the pipe shall be grit blasted and primed with an approved primer.The lining shall be inaccordancewithBSEN10311&BSEN10224.Afterinstallation,theinternalliningsh all bemade good and satisfactorily tested with a Holiday detector to 8 KV.

The coating shall be suitable for use in contact with drinking water.The type of coating shall be enteredin Schedule L provided andtheEngineer reserves the right tocallfortest plates of the paint. Themanufacturershallatthetimeoforderingcarryoutthe`Tasteandsmelltest'(Appen dixEofBS EN 10300) and `Effects on water test' (Appendix C of B.S. 3416) and forward 3 copies of the test results to the Engineer for approval.

Wherepipeareto beweldedaftertheprotective coatingshave been applied the pipe surfaces shallbeprimedandallothercoatingstopped250mmshortoftheweldpreparation.Collarsand fillings shall be primed but no other coating applied.

The manufacturer shall supplya sufficient quantityof suitablematerials to repair damageoccurring duringdeliverytositeand to providedaflushfinished internallliningat welded joints.Heshall supplysufficientcoatingtofillintherecessesat internal weldsoverthepreviouslyprimedareas.The costs of these materials shall be included in the unit rates for the supply of the pipes and specials.

Thecoatingshallbeappliedinaccordancewiththemanufacturer'sinstructionsandwithAppendices J and K of B.S. 3416.

Machinery-(Internalsurfaces)e.g.pumps,valves,strainers,risingandsuspensionmainsofwetwell pumps:

Asforcastironandsteelpipework(Internalsurfaces).

Castironandsteelparts(Externalsurfaces)immersedin Water:

Allungalvanisedmetalpartswhichwillbeimmersedinwatershallbecleanedbygritblastingand within four hours of blasting given an approved coating.

Castironandsteel(Externalsurfaces)inmanholesandareasofhigh humidity.

Ungalvanisedmetalpartsexposedinmanholesorareasofhighhumidityshallbecleanedbygrit blasting and given two coats of a black bituminous solution.

(b) Plantforwardedtositeforfinal finishing.

Castironandsteelparts(Externalsurfaces)outside buildings:

Allungalvanisedmetalpartswhichwillbeexposedtotheoutsideatmosphereshallbecleanedby grit blastingandprovided with two coats ofanapproved primer.

Castironandsteel partsinsidebuildings:

Allexposedmetalsurfaceswhichwillnotbeimmersedinwaterorexposedinareasdescribedabove shallberubbeddown, cleaned bygrit blastingand withinfour hours of blastinggiven one coatofan approvedprimer before packing.

PaintingatSite

Immediately on arrival at the site, all items of plant shall be examined for damage to the paintcoatappliedatthemanufacturer'sworks,andanydamagedportionsshallbecleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.

Steel and cast iron parts received at site shall be provided with adequate numberof further coats of coal tar epoxy polyamine coating or Polyurethane coating as specified & approved, to a total dry film thickness of minimum 250 microns including the primer coats.All sharp edges, nuts, bolts and other items difficult to be painted shall receive a brush coat of specified paint before application of each coat of epoxy based paint giving a total dry film thickness of at least 250 microns. In the case of fabricated steelwork this work shall be done after assembly.

Before painting is commenced the Contractor shall submit for the approval of the Engineer, full details of the paints he proposes to use together with colour charts for the glossy finishes.

After erection, such items which are not finish painted shall be finish painted, items finish painted at the Manufacturer's works shall be touched up for any damaged paint work.

Thepaintingwork shallconformto thefollowingrequirements:

(a)The surface preparation shall be carried out generally in

accordance with IS: 1477 Part I and IS: 6005

(b) After surface preparation, two coats of primer-red oxide zinc chromate with modified phenolic alkyd base conforming to IS: 2074 shall be applied. Dry film thickness of each coat shall be 25 microns.

(c) For finish painting, after application of primer as in (b) above, two coats of synthetic enamel conforming to IS: 2932 shall be applied. Dry film thickness of each coat shall be 25 microns.

d) Colours shall be selected as per IS: 5.

No painting shall be carried out unless the item has been inspected and accepted by Engineer at the Manufacturer's works

The dry paint film thickness shall be measured by Electrometer or other instruments approved by the Employer. In order to obtain the dry film thickness DFT specified, the Contractor shall ensure that the coverage rate given by the paint manufacturer will enable this thickness to be obtained. Strength of adhesion shall be measured with an adhesion tester and this value shall not be less than 10 kg/cm^2.
Painted fabricated steel Work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no. pole sof water or dirt can accumulate on the surface. Suitable packings shall be laid between the stacked Materials. Where cover is provided, it shall be ventilated.

The painting procedure shall be submitted in the following format for approval:

(a) Surface Preparation
(b) Reference Standard
(c) Conditions of Work
(d) Type of Materials
(e) Tests and inspection methods and sequence, thickness (DFT)
(f) Colour in final coat
(g) Total thickness of coats (DFT)
(h) Other necessary data and information

The following items in the plant are required to be painted;

(a) Outer surfaces of pumps, valves, pipes, fittings, motors etc., not exposed to treated water
(b) Steel work exposed to weather, such as outer surface of surge vessel, valves, pipes etc.

(c) InternalPlantandpipework,cranes,exhaustfans,fireextinguishersand miscellaneous steelwork not exposed to weather

(d) Steelworkexposedtoweather,suchasplatforms,ladders,handrailing,etc.
(e) Steelworkexposedtohumidweatherandrequiringhardmaintenanceandrepairs
(f) Buriedsteelwork
(g) Buriedpipesandfittingspriortoapplicationofwrapping
(h) Otherequipment,asperrequirementofemployer.

Allburiedsteelpipesandfittingsshallbecoatedandunwrappedwithhotorcoldapplied, self- adhesive, polyethylene in accordance with AWWA C214 or equivalent Standard.

Castironor mildsteel partsto be builtinto concreteshallremain unpainted.Immediatelybefore itis castin-situ,itshallbemadeperfectlyfreefromdirt,scale,looserust,paint,oil limewashor anyother coating.

NoblastcleaningorpaintingshallbeappliedtocorrosionresistantMaterialssuchass tainlesssteels. Ni-resist cast iron, bronze and other metals used for seals, bearings, lighting fitting etc.

Machined surfaces such as gear teeth shall be coated with a thick layer of grease. Other mechanical surfacessuchasshaftendsorotherbright partsshallbecoatedwithtwocoatsofananti-rust solution which can be removed easily when required.Permanently bolted mechanical interfaces such as flanges shall be coated with a thin coat of anti-rust compound before assembly.

Allprimers,undercoatsandfinishesshallbeappliedbybrushorairlessspray,exceptwhereotherwise specified.

Consecutivecoatsshallbeindistinctbutappropriateshades.Allpaintsshallbesupplied fromthe store to the painters, ready for application, and addition of thinners or any other Material shall be prohibited.Any instruction given by the paint manufacturer shall be strictly followed.

All paintingshallbecarriedout bythepaintersundersupervision.Paint shall beappliedtothedry surface which has been prepared in compliance with the approved procedure.

No site painting shall be carried out unless the surface to be painted is dry, the

air temperature above 4oC and the relative humidity less than 85%.
The Plant and equipment shall be inspected and reviewed at the various stages of the coating applicationbothatthemanufacturer’sWorksandattheSiteoftheWorks.Samplesmay betaken

fromthepaintsasdeliveredandsubmittedtosuchtestsasaredeemednecessary.Theco mpletedpaint systems shall be tested by instruments to ensure that the protection is of adequate thickness and is free from pinholes and the direct measurement of adhesion shall be checked by the removal of a small section of the coating.TheContractor shall supplyall instruments and apparatus required for carrying out such tests required by the Employer.

WaterworksFinish

Ahighstandardoffinish,definedas“Waterworksfinish"isrequiredforallPlantasdetailedbe low.

Weldingandflamecutting

A smooth neat finish, by careful grinding if necessary is required on all exterior welding and flame cutting.Allplatesandbarsusedinfabricationshall havesmoothsurfaceswithnopittingordeepslag inclusions

Castings

Castingsurfacesshallbesmoothandfreefromsurfaceblowholes.Stockcastingsshallb especially selected with this in mind. All castings shall be shot blasted before machining.

Covers

All coversshall befirmlyfixed.Weldmeshshallsit squareinitsframe.Wherepanelsareplaced next to each other the patterns shall line up.

Flangesandbeadings

Allboltholesshallbespotfacedparallelwiththematingfaceforgoodseatingofnutsand boltheads. Surplus jointing shall be removed from mating faces and peripheries.

Itemstobechromiumplated

Nameplates,instructionplates,rotationarrows, indicatorsand pointers, small bore pipework, tundish oil level gauges and fittings, small valves(including air valves), plugs and grease nipples, whicharesitedinarchitecturallyfinishedareasofthestationandasselectedbytheEn gineer,shall bechromiumplated.Damage to chromium plating shall be made good.

Allpipesandfittingsetc.,shall befittedinastraight,neat symmetrical mannersoastopresenta pleasing appearance.

Externalscrews,boltheads,nutsandwashers

Theseshallbechromiumplated,sherardisedormadeinstainlesssteel.

Gauges

All indicating gauges fitted to any machine assembly shall be of similar appearance and grouped togethertopresentapleasingaspect.Theyshallallhavechromiumplatedcases,bezels, cocksand fittings.

PaintingofValvesandMechanical Equipment

a. PriortoInspection

i. SurfacePreparation:SandBlastingtoSA2½Grade–Nearwhiteblastcleaning.

ii. ApplicationofPrimerCoatingafterblast cleaning.

b. PostInspection

i. ApplicationofIntermediateCoat:

ii. Onecoatoftwocomponenthighbuildpolyamidecrudere-coatableepoxycoatingto achieve DFT 150 micron.

iii. ApplicationofFinishCoat:

Onecoatoftwocomponentaliphaticpolyurethanefinishestoachieve DFT100micron.

TotalPaintingDFTshallbeminimum250microns.

EndofPart9

PART 9

GENERALPAINTINGANDPROTECTIONREQUIREMENTS

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PART 9

GENERALPAINTINGANDPROTECTION REQUIREMENTS

General

Thepreparation,applicationandconditionsforworkshallcomplywiththerecommendations ofBS 5493 and BS 6150 or if the protection is of a special nature, in accordance with the manufacturer's directions.

Paints,primersandundercoatsshallbeobtainedfromthesamemanufacturerandexcept whereadefinite time is specified between mixingandapplication,shallbe readymixed for use.Theyshallbe compatible with one another.

Paintsshallbedeliveredinsealedcontainersbearingthemanufacturer'sname,batchnumber,etc.and shall carry a label giving details of quality and instructions for use.

Nositepaintingshallbecarriedoutunlessthesurfacetobepaintedisdry,theairtemperatureabove4°C and the relative humidity less than 85%. The Engineer shall approve the methods for removing all dirt, oil, grease, etc, before Site painting commences.

Test platescarryingfinishesfromtheactual coatingusedmayberequiredbytheEngineerforinspection and test purposes.

Tofacilitateinspection,noconsecutivecoatsofpaintshallbeofthesameshadeexceptinthecaseof white.

Primingtotwomatingsurfacesshallbeappliedpriorto assembly.

All items of Plant shall be delivered to Site with the shop paint finish applied unless specified otherwise. A further coat of final finish paint shall be applied at Site, of sufficient thickness to produce a uniform colourandappearance.Suchpaintingshallbecarriedoutwithinonemonthof successfulacceptancetrials for the Plant.

Allpaintthicknessesshallbecheckedusinganalkometerorequivalentinstrument,supplie dbythe Contractor, for each layer of paint, to the reasonable satisfaction of the Engineer.

ColourCoding andLabelling of Pipes and Equipment

All pipes and equipment shall be colour coded to a schedule to be agreed with the Engineer before any site painting starts, or earlier if necessary to suit manufacturing procedures. Valves and fittings shall be paintedinthesamecolourasthepipeofwhichtheyformapart.Whereapipeentersorleave sapieceof equipment the pipe colour shall extend up to but not including the flange attached to the equipment.

All pipelines shall be identified by stick-on 90 micron thick vinyl film labels showing the name of the material tobe carried bythe pipeline and anarrowindicatingthe direction of flow. Letters oftitlesshall be pre-spaced on carriertape andthecompletetitle protected byonepieceremovableliners.Titles shall beatintervalsnotlessthan8m,butshallinanycasebeprovidedineveryspacethroughwhi chthepipe passes. Locations of labels shall be subject to prior approval by the Engineer. Lettering sizes shall be between 16 mm and 75 mm in height depending on the size of the pipe.

Pipes smaller than 22 mm outside diameter shall be labelled by the use of tags instead of labels. Tags shall bemadeofbrassnosmaller than65mmx16 mmby1.5 mmthick,withletteringetchedandfilled with black enamel.

TitlesshallalsobeprovidedonallequipmentinlocationsandinsizestobeapprovedbytheEn gineer.

CleaningandPreparingatPlaceof Manufacture

TheContractorshallberesponsibleforthecleaningandpreparationforpainting,primin gorother wise protectingas specified of all parts of thePlantat the place of manufacture prior to packing.

(a) Cleaning

Partsshallbecleanedpriortotestingatthemanufacturer'sworks.Partssubjectto hydraulictest shall be tested before any surface treatment. After test all surfaces shall be thoroughly cleaned and dried out if necessary by washing with an approved dewatering fluid prior to surface treatment.

(b) Preparation

Brightparts:Brightpartsandbearingsurfacesshallbethoroughlypolishedandprotectedfrom corrosionby theapplicationof rust preventivelacquerorhigh melting-pointgrease,as approvedbytheEngineer, before the parts are packed.A sufficient quantityof thecorrect solventfor removaloftheprotective compoundsshallbesuppliedandpackedwitheach particular part.

Embeddedparts:Embedded parts or those partsofan assemblywhich will be embedded in concrete shallbe thoroughly descaled and cleaned to the satisfaction of the Engineerandbeforebeingpacked shallbe protectedby a cement wash or otherapprovedmethod.Nocastiron or steel work shall be bitumenortarcoatedwhereitistobecastintotheconcreteandprovisionshallbemadeforcleaning off anyportions so coated.

Gritorshotblastedparts:GritorshotblastingshallbecarriedoutinaccordancewithB.S.7079toa standardbetween `First Quality' and `SecondQuality' givenin Table 1 after which the maximum amplitudeof the surface shall not exceed 0.1 mm.

CastIron and Steel pipework:All ungalvanisedsteel pipeworkincludingpumpsuspensionmains, bearingspidersandtunneltubesshallbepreparedinternallyandexternallybygrit orshot blastingas specified above and the surfaces primed as specified withinfour hours of blasting.

PaintingandFinishingatPlaceofManufacture

ThisClausegoverns the methodsfortheprotective coatingsto be applied to structural steel, metalworkandironworkascorrosionprotectionsystems.Thesystemsdesignedasspecifiedhereshall be applied as specifiedunder ProtectiveCoatings. Protective coatingspecified elsewhere for particular workssuch aspipesand cladding shall firstlybedesignedin accordancewithparticular requirementsspecified elsewhereandsecondlyinaccordancewithany requirements herein which are not overridden elsewhere.This specification makes reference to the following standard.

B.S.5493"codeofpracticefortheprotectivecoatingofironandsteelagainstcorrosion"

TheContractorshalldesigneachprotectivecoatingsystemandshallsubmitdetailsofeachsystemtothe Engineerfor approval.Submissionsshallwhere possiblebe in the

format of which examples are
givenattheendofthissectionwithsuchadditionalinformationandsamplesastheContrac
tormay provide or the Engineer may require to enable the system tobe assessed.

Protective coating shall be designed in accordance with B.S. 5493 or equivalent to have a long life, generally of at least 10 years to first maintenance.Protection systems shall be chosen to be easily maintainedinthefutureandtoallownon-specialiston-sitere-coatingwherenecessaryusingsinglepart paints.

Forthe purposes of systemdesignthegeneralenvironment shall be asspecified in B.S.5493Table3
Part2`Exteriorexposedpollutedinland'.Bulkheadgatesandstoplogsshallbeassumedt obeexposedto a Table 3 Part 8 `Non-saline water' environment unless otherwise approved by the Engineer.

Interiorspacesshallbeconsideredtobedryinadministrationareasopentocontinuousa ccessanddamp or immersed in other spaces.The protective coating of componentsorstructures whichare continuouslyor infrequentlyimmersed shall be designed forthemore onerousofthesetwo conditionsrelevanttothe protection system used.

Allexteriorexposeditemstobecoatedshallhaveafinalcoatofgoodappearanceofacolour andtypeas approved by the Engineer.

Protectivecoatingsystemsshallgenerallyfallintooneofthefollowingbasicsystems;

- galvanising;
- galvanisingpluspainting;
- multi-coatpainting;
- Bitumenenamel;
- OthersasproposedbytheContractorandapprovedbytheEngineer.

TheContractorshallsubmittotheEngineerdetailsofhisproposalsforthecorrosionprote ctionofeachof theitems requiring such protection, whichwill generally fall into the above categories as follows:

- trashscreens, flooring, ladders,accesscovers and frames, step irons and other componentswhich are inaccessible but subject to abrasion/damage;
- structuralsteelwork(includingcranebeams, monorails, crane structures and chassis), bulkhead gates, stoplogs, grappling beams, steel tanksand otherlargeitemsreadilyaccessiblefor maintenance;

- valves and other corrosion-susceptible items which maybeburiedandarenotcoveredbythe provisions of other specifications :
- othercomponentsnot covered bytheabovefor which the contractor may propose a system which he considers to be more suitable for the duty;
- electricalswitchgear,transformers,controlpanelsetc.

Allpaintingmaterialshallbeappliedinstrictaccordancewiththepaintmanufacturer'sinstructions.

(a) Plantsuppliedtositewithfinalcoatingapplied:

Cubicles,cabinetsetc.otherthanthosespecifiedinPart10ofSection4.

Beforeanysteel work is painted thesteelmustbe thoroughly cleaned and an approved anti-rusting priming coatappliedso that the possibilityofrustingor corrosiontakingplace is negligible. All surfaces should have not less than two stoved undercoats and two top coats or air drying paint. The undercoats shall be easily distinguishable in shade or colour form the priming and finishing coats. The two final coats shall be in a colour and finish to be advisedbythe Engineer.Theinsidesurfacesofany cubicles, cabinetsetc. where condensation is liabletooccur, shall becoated withanapprovedanti-condensationcomposition.TheContractorshallensurethatallcomponentsectionsofaswitchboard wherever manufactured shall have a finish of uniform texture and an exact colour match.

Chromiumplatedparts:Wherechromiumplatingis specifiedorofferedby themanufactureritshall comply with the requirements of BS EN ISO 1456 including the followingprovisions.No blistering of any surfaces will be tolerated.The finished appearance shall be brought.Where the base metal is steel, plating shall be applied in accordance with Table 2. Other base metals shall be plated in accordancewithTables3,4,5asappropriate.Forallbasemetalstheserviceconditionnumber2shallbe used.

Small bore pipes, valves and fittings etc., which are sited in architecturally finished areas of the station andselectedbytheEngineershallbechromiumplated.Damagetochromiumplatingshall bemadegood before taking over.

Galvanised parts:All materials to be galvanised shall beofthefulldimensionsshownonthe approveddrawingsorspecifiedandallpunching,cutting,drilling,screwtappingandthe removalof burrsshall becompletedbefore the galvanisingprocessbegins.Parts to be galvanised shall be shot blasted as specified above.Such parts shall be

galvanised not more thanfour hours after commencement of shot blasting.

All galvanising shall be done by the hot dip-process.No alternative process may be used without the approvaloftheEngineer.Nocomponentsshallbegalvanisedwhicharelikelytocomeintosubsequent contact with oil.

The zinc coating shall be uniform, clean smooth and as free from spangle as possible.In the caseof componentpartsthezinccoatingshallweighnotlessthat610g/sq.mofareacoveredandshallnotbeless than 0.090 mm in thickness.

Boltsandnutsshallbesherardised.TheEngineermayselectfortestasmanycomponentsto beweighed after pickling, and before and after galvanizing as he may think fit.

Allgalvanisedpartsshallbeprotectedfrominjurytothezinccoatingduetodifferentialserrationand abrasionduringthe periods of transit,storageand erection.Damaged areas of the coating shall be touched up with an approved zinc-dust paint or other approved flake metallic compound.

Castironandsteelpipework:(Internalsurfaces)

Theinternalsurfacesshallhaveanapproved coating.

Whereabitumenbasedcoatingisused,itshallbeinaccordancewithType2ofBSEN 10300.

Prior to lining, the pipe shall be grit blasted and primed with an approved primer.The lining shall be in accordancewithBSEN10311&BSEN10224.Afterinstallation,theinternalliningshallbemadegood and satisfactorily tested with a Holiday detector to 8 KV.

Thecoatingshall besuitableforuseincontact withdrinkingwater.Thetypeofcoatingshall beentered in Schedule L provided and the Engineer reserves the right to call for test plates of the paint. The manufacturer shall at the time of ordering carry out the `Taste and smell test' (Appendix E of BS EN 10300) and `Effects on water test' (Appendix C of B.S. 3416) and forward 3 copies of the test results to the Engineer for approval.

Wherepipearetobeweldedaftertheprotectivecoatingshavebeenappliedthepipesurfacesshall be primedand all other coating stopped 250 mmshortof theweld preparation.Collars and fillings shall be primed but no other coating applied.

The manufacturer shall supply a sufficient quantityof suitablematerials to repair damageoccurring duringdeliverytositeand to providedaflushfinished internalliningat welded joints.Heshall supplysufficientcoatingtofillintherecessesat internal weldsoverthepreviouslyprimedareas.The costs of these materials shall be included in the unit rates for the supply of the pipes and specials.

Thecoatingshallbeappliedinaccordancewiththemanufacturer'sinstructionsandwithAppendices J and K of B.S. 3416.

Machinery-
(Internalsurfaces)e.g.pumps,valves,strainers,risingandsuspensionmainsofwetwell pumps:

Asforcastironandsteelpipework(Internalsurfaces).

Castironandsteelparts(Externalsurfaces)immersedin Water:

Allungalvanisedmetalpartswhichwillbeimmersedinwatershallbecleanedbygritblastingandwithin four hours of blasting given an approved coating.

Castironandsteel(Externalsurfaces)inmanholesandareasofhigh humidity.

Ungalvanisedmetalpartsexposedinmanholesorareasofhighhumidityshallbecleanedbygritblasting and given two coats of a black bituminous solution.

(b) Plantforwardedtositeforfinal finishing.

Castironandsteelparts(Externalsurfaces)outside buildings:

Allungalvanisedmetalpartswhichwillbeexposedtotheoutsideatmosphereshallbecl eanedby grit blastingandprovided with two coats ofanapproved primer.

Castironandsteel partsinsidebuildings:

Allexposedmetalsurfaceswhichwillnotbeimmersedinwaterorexposedinareasdescr ibedabove shallberubbeddown, cleaned bygrit blastingand withinfour hours of blastinggiven one coatofan approvedprimer before packing.

PaintingatSite

Immediatelyonarrivalatthesite,allitems ofplantshallbeexaminedfordamagetothepaint coatappliedatthemanufacturer'sworks,and anydamagedportionsshallbecleaneddownto the bare metal, all rust removed, and the paint coat made good with similar paint.

Steel and cast iron parts received at site shall be provided with adequate number of further coats of coal tar epoxy polyamine coating or Polyurethane coating as specified & approved, to a total dry film thickness of minimum 250 microns including the primer coats.All sharp edges,nuts,boltsandotheritemsdifficulttobepaintedshallreceiveabrushcoat ofspecified paint before application of each coat of epoxybased paint giving a total dryfilm thickness of at least 250 microns. In the case of fabricated steelwork this work shall be done after assembly.

Before painting is commenced the Contractor shall submit for the approval of the Engineer, full details of thepaints heproposes tousetogether with colourcharts for theglossyfinishes.

After erection, such items which are not finish painted shall be finish painted, items finish painted at the Manufacturer's works shall be touched up for any damaged paint work.

Thepaintingwork shallconformto thefollowingrequirements:

(a) Thesurfacepreparationshallbecarriedoutgenerallyinaccordancewith IS:1477 Part I and IS: 6005

(b) After surface preparation, two coats of primer-red oxide zinc chromate with modified phenolic alkyd base conforming to IS: 2074 shall be applied. Dry film thickness of each coat shall be 25 microns.

(d) For finish painting, after application of primer as in (b) above, two coats of synthetic enamel conforming to IS: 2932 shall be applied. Dryfilm thickness of each coat shall be 25 microns.

d) Colours shall be selected as per IS:5.

No painting shall be carried out unless the item has been inspected and accepted by Engineer at the Manufacturer's works

The dry paint film thickness shall be measured by Electrometer or other instruments approved by the Employer. In order to obtain the dry film thickness DFT specified, the Contractor shall ensure that the coverage rate given by the paint manufacturer will enable this thickness to be obtained. Strength of adhesion shall be measured with an adhesion tester and this value shall not be less than 10 kg/cm^2.

Painted fabricated steel Work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no. poles of water or dirt can accumulate on the surface. Suitable packings shall be laid between the stacked Materials. Where cover is provided, it shall be ventilated.

The painting procedure shall be submitted in the following format for approval:

(i) Surface Preparation
(j) Reference Standard
(k) Conditions of Work
(l) Type of Materials
(m) Tests and inspection methods and sequence, thickness (DFT)
(n) Colour in final coat
(o) Total thickness of coats (DFT)
(p) Other necessary data and information

The following items in the plant are required to be painted;

(i) Outer surfaces of pumps, valves, pipes, fittings, motors etc., not exposed to treated water
(j) Steel work exposed to weather, such as outer surface of surge vessel, valves, pi

pesetc.

(k) Internal Plant and pipework, cranes, exhaust fans, fire extinguishers and miscellaneoussteelwork not exposed to weather
(l) Steelworkexposedtoweather,suchasplatforms,ladders,handrailing,etc.
(m) Steelworkexposedtohumidweatherandrequiringhardmaintenanceandrepairs
(n) Buriedsteelwork
(o) Buriedpipesandfittingspriortoapplicationofwrapping
(p) Otherequipment,asperrequirementof employer.

Allburiedsteelpipesandfittingsshallbecoatedandunwrappedwithhotorcoldapplied,self-adhesive, polyethylene in accordance with AWWA C214 or equivalent Standard.

Castironormildsteel partstobebuiltintoconcreteshallremainunpainted.Immediatelybeforeitiscast in-situ,itshallbemadeperfectlyfreefromdirt,scale,looserust,paint,oillimewashoranyother coating.

NoblastcleaningorpaintingshallbeappliedtocorrosionresistantMaterialssuch asstainlesssteels.Ni- resist cast iron, bronze and other metals used for seals, bearings, lighting fitting etc.

Machined surfaces such as gear teeth shall be coated with a thick layer of grease. Other mechanical surfaces such as shaft ends or other bright parts shall be coated with two coats of an anti-rust solution whichcanberemovedeasilywhenrequired.Permanentlyboltedmechanicalinterfacessuchasflanges shall be coated with a thin coat of anti-rust compound before assembly.

Allprimers,undercoatsandfinishesshallbeappliedbybrushorairlessspray,exceptwhere otherwise specified.

Consecutivecoatsshallbeindistinctbutappropriateshades.Allpaintsshallbesuppliedfromthestore to the painters, ready for application, and addition of thinners or any other Material shall be prohibited. Any instruction given by the paint manufacturer shall be strictly followed.

Allpaintingshallbecarriedoutbythepaintersundersupervision.Paintshallbeappliedto thedry surface which has been prepared in compliance with the approved procedure.

No site painting shall be carried out unless the surface to be painted is dry, the air temperature above 4oC and the relative humidity less than 85%.

The Plant and equipment shall be inspected and reviewed at the various stages of the coating application both at the manufacturer’s Works and at the Site of the Works.Samples may be taken from the paints as delivered and submitted to such tests as are deemed necessary.The completed paint systems shall be tested by instruments to ensure that the protection is of adequate thickness and is free from pinholes and the directmeasurementof adhesion shallbe checked by the removalof a small section of the coating. The Contractor shall supply all instruments and apparatus required for carrying out such tests required by the Employer.

WaterworksFinish

Ahighstandardoffinish,definedas“Waterworksfinish"isrequiredforallPlantasdetailedbelow.

Weldingandflamecutting

A smooth neat finish, by careful grinding if necessary is required on all exterior welding and flame cutting.Allplatesandbarsusedinfabricationshallhavesmoothsurfaceswithnopittingordeepslag inclusions

Castings

Castingsurfacesshallbesmoothandfreefromsurfaceblowholes.Stockcastingsshallbespecially selected with this in mind. All castings shall be shot blasted before machining.

Covers

Allcoversshallbefirmlyfixed.Weldmeshshallsitsquareinitsframe.Wherepanelsareplacednextto each other the patterns shall line up.

Flangesandbeadings

Allboltholesshallbespotfacedparallelwiththematingfaceforgoodseatingofnutsandbolt heads. Surplus jointing shall be removed from mating faces and peripheries.

Itemstobechromiumplated

Nameplates,instructionplates,rotationarrows, indicatorsand pointers, small bore pipework,tundishoillevelgaugesandfittings,smallvalves(includingairvalves),plugsandgreasenipples,which aresited in architecturally finished areas of the station and as selectedbythe Engineer, shall be chromiumplated.Damage to chromium plating shall be made good.

Allpipesandfittingsetc.,shallbefittedinastraight,neatsymmetricalmannersoastopresen ta pleasing appearance.

Externalscrews,boltheads,nutsandwashers

Theseshallbechromiumplated,sherardisedormadeinstainlesssteel.

Gauges

Allindicatinggaugesfittedtoanymachineassemblyshallbeofsimilarappearanceandgro upedtogether to present a pleasing aspect. They shall all have chromium plated cases, bezels, cocks and fittings.

PaintingofValvesandMechanical Equipment

c. PriortoInspection

iii. SurfacePreparation:SandBlastingtoSA2½Grade–Nearwhiteblastcleaning.

iv. ApplicationofPrimerCoatingafterblast cleaning.

d. PostInspection

iv. ApplicationofIntermediateCoat:

v. Onecoatoftwocomponenthighbuildpolyamidecrudere-coatableepoxycoatingto achieve DFT 150 micron.

vi. ApplicationofFinishCoat:

Onecoatoftwocomponentaliphaticpolyurethanefinishestoachieve DFT 100micron.

TotalPaintingDFTshallbeminimum250microns.

EndofPart9

PART10A

CIVIL,STRUCTURALANDSEWERNETWORKREQUIREMENTS

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SECTION1

SITECLEARANCE(CLEARINGANDGRUBBING)

SECTION1

SITECLEARANCE(CLEARINGANDGRUBBING)

Scope

Thisworkshallconsistofcutting,removinganddisposingofallmaterialssuchastrees,bushes,
shrubs,stumps,roots,grass,weeds,toporganicsoilnotexceeding150mminthickness,rubbish etc., from the area of Works which in the opinion of the Engineer are unsuitable for incorporation in the Works, and such other areas as maybe specified on the Drawings or bythe Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials.
Clearingandgrubbingshallbeperformedinadvanceofearthworkoperationsand inaccordance with the requirements of these Specifications.

PreservationofProperty/Amenities

Trees,shrubs,anyotherplants,polelines,fences,signs,monuments,buildings,pipelines,sewers and all facilities within or adjacent to the site which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own expense, suitable safeguards approved by the Engineer for this purpose.

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional Works to that effect vide relevant Clauses of section 3 Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal ofwastematerials,etc.,andtheschedulesforcarryingouttemporaryandpermanenterosioncontrol Works as stipulated in section 3.

Methods,Toolsand Equipment

Only such methods, tools and equipment as are approved by the Engineer and which will not affectthepropertyto be preserved
shallbeadoptedfortheWork.Ifthe areahas thick vegetation
/roots/
trees,acrawlerorpneumatictyreddozerofadequatecapacitymaybeusedforclear

ance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc., falling within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade / foundation / bed level. Also, all vegetation such as roots, under-growths, grass and other deleterious matter unsuitable for incorporation in

the Work shall be removed between fill lines to the satisfaction of the Engineer. On the areas beyondtheselimits,treesandstumpsrequiredtoberemovedasdirectedbytheEngineershallbe cut down to 1 m below ground level so that these do not present any unsightly appearance.

Allbranches of treesextendingabovethe roadwayshall betrimmed as directed bythe Engineer.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shallbefilledwithsuitablematerialandcompactedthoroughlysoastomakethesurfaceasthese points conform to the surrounding area.
Ant-hills both above and below the ground, as are liable to collapse and obstruct free subsoil waterflowshallberemovedandtheirworkings,whichmayextendtoseveralmeters,shallbe suitably treated.

DisposalofMaterials

All materials arisingfrom clearingand grubbing operations shall be the propertyof Employer andshallbedisposedofbytheContractorashereinafterprovidedordirectedbytheEngineer.

Trunksandstumpsoftreesshallbecleanedoflimbsandrootsandstacked.Alsoboulders,stones and other materials usable in construction shall be neatly stacked as directed by the Engineer.
Stackingstumps, boulders,stones etc.,shall bedoneatspecified spotswith alllifts and lead.

All products of clearing and grubbing which, in the opinion of the Engineer, cannot be used or auctionedshallbeclearedawayfromthe siteinamannerasdirectedbytheEngineer.Careshall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for construction.

MeasurementsforPayment

Clearing and grubbing shall be measured on area basis in terms of hectares. Clearing and grubbing of borrow areas shall be deemed to be a part of Works preparatory to embankment construction and shall be deemed to have been included in the rates quoted for the embankment constructionitemandnoseparatepaymentshallbemadeforthesame.Cuttingoftrees upto300 mm in girth includingremoval of stumps and roots, and trimmingof branches of trees extending above the roadway shall be considered incidental to the clearing and grubbing operations.

Removalofstumpsleftoveraftertreeshavebeen cutbyanyotheragencyshallalsobe considered incidental to the clearing and grubbing operations.

Cutting,includingremovalofstumpsandrootsoftreesofgirthabove300mmandbackfillingto required compaction shall be measured in terms of number according to the sizes given below:

Above300 mm to 600 mm;
Above 600 mm to 900 mm;
Above900mmto1800mm;and

Above1800 mm.

Forthispurpose,thegirthshallbemeasuredataheightof1mabovegroundoratthetopofthe stump if the height of the stump is less than 1 m from the ground.

Rates

TheContractunitratesforthevariousitemsofclearingandgrubbingshallbepayment infullfor carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps of trees less than 300 mm in girth as well as stumps left overafter cuttingof trees carried out by another agency, excavation and back-filling to required density, where necessary, and handling, salvaging, piling and disposing of the cleared materials with all lifts and leads.

TheContractunitratesforcutting(includingremovalofstumpsandroots)oftreesofgirth above300 mm shall includeexcavation and back-fillingto required compaction, handling, salvaging, piling and disposing of the cleared materials with all lifts and lead.

Where a Contract does not include separate items of clearing and grubbing, the same shall be consideredincidentaltotheearthworkitemsandtheContractunitpricesforthesameshallbe considered as including clearing and grubbing operations.

EndofSection-1

SECTION2

DISMANTLINGANDDEMOLITION

SECTION2

DISMANTLINGANDDEMOLITION

Scope

This work shall consist of removing, as hereinafter set forth, existing buildings, roofs, ceiling, flooring and paving, concrete and brick roofs and suspended floors, walls and columns, reinforced concrete and brick work, partitions, wood work, steel and iron work, doors and windows, pipes and sewer lines, posts or struts, fencing wire mesh, glazing, culverts, bridges, pavements, kerbs and other structures like guard-rails, utilityservices, catch basins, inlets, etc., whichareinplacebutinterferewiththenewconstructionorarenotsuitabletorem aininplace, and of salvagingand disposing of the resulting materials and back filling the resulting trenches and pits.

Existing culverts, bridges, pavements and other structures which are within the highway and whicharedesignatedforremoval,shallberemoveduptothelimitsandextentspeci fiedinthe Drawings or as indicated by the Engineer.

Dismantling and removal operations shall be carried out with such equipment and in such a mannerastoleaveundisturbed,adjacentpavement,structuresandanyotherwor ktobeleftin place.

Alloperationsnecessaryfortheremovalofanyexistingstructurewhichmightendan gernew construction shall be completed prior to the start of new work.

ApplicableCodes

IS:1200-1974 (Part:XVIII)	MethodofMeasurementsofBuildingandCivilEngineeringW orks. DemolitionandDismantling(Reaffirmed2002) (3rdRevision).
IS:4130-1991	DemolitionofBuildings -CodeofSafety(2nd Revision).

Terminology

Theterm‘Dismantling’impliescarefullyseparatingthepartswithoutdamageand removing. This may consist of dismantling one or more parts of the structure as specified.

Theterm‘Demolition’impliesbreakingup.Thisshallconsistofdemolishingwhole orpartof work including all relevant items as specified.

Buildings

Precautions

Allmaterialsobtainedfromdismantlingordemolitionshallbethepropertyoft heEmployer unlessotherwisespecifiedandshallbekeptinsafecustodyuntiltheyarehande dovertothe Engineer.

Thedemolitionshallalwaysbewellplannedbeforehandandshallgenerallybedon einreverse order of the one in which the structure was constructed. The operations shall be got approved from the Engineer-In-Charge before starting the work.

Duecareshallbetakentomaintain thesafetymeasures prescribedinIS: 4130.

Necessary propping, shoring and or under pinning shall be provided to ensure the safety of the adjoiningworkorpropertybeforedismantlinganddemolishingistakenupandthew orkshallbe carried out in such a way that no damage is caused to the adjoining work or property. Wherever specified, temporaryenclosures or partitions shall also be provided, as directed bythe Engineer.

Necessaryprecautions shall betaken to keepdown the dustnuisanceto theminimum.

Dismantlingshallbedoneinasystemicmanner.Allmaterialswhicharelikelytobeda magedby dropping from a height or by demolishing roofs, masonry etc. shall be carefully removed first. Thedismantledarticlesshallberemovedmanuallyorotherwise,loweredtothegrou nd(andnot thrown) and then properly stacked as directed by the Engineer.

Whereexistingfixingisdonebynails,screws,bolts,rivets,etc.,dismantlingshallbe doneby taking out the fixing with proper tools and not by tearing or ripping off.

Anyserviceablematerial,obtainedduringdismantlingordemolition,shallbesep aratedoutand stacked properlyas directed bythe Engineer within a lead of 50 m. All unserviceable materials rubbish etc. shall be disposed off as directed by the Engineer.

TheContractorshallmaintain/ disconnectexistingservices,whethertemporaryorpermanent, where required by the Engineer.

Measurements

Allworkshallbemeasurednetinthedecimalsystem,asfixedinitsplace,subjecttot
he following limits, unless otherwise stated hereinafter.

1. Dimensionsshallbemeasuredcorrecttoacm.

2. Areasshallbeworkedout insqmtcorrecttotwoplacesofdecimal.
3. Cubicalcontentsshallbeworkedouttothenearest0.01cum.

Partsofworkrequiredtobedismantledandthoserequiredtobedemolishedshallbe measured separately.

Measurementsofallworksexcepthiddenworkshallbetakenbeforedemolitionor dismantling and no allowance for increase in bulk shall be allowed.

Specificationsfordeductionforvoids,openingsetc.shallbeonthesamebasisast hatadopted for new construction of the work.
Workexecutedin thefollowingconditionsshall bemeasured separately:

1. Workinorunder waterand/orliquid mud;
2. Workinorunderfoul position.

Rates

The rate shall include the cost of all labour involved and tools used in demolishing and dismantlingincludingscaffolding.Therateshallalsoincludethechargesforsepar atingoutand stacking the serviceable material properly and disposing off unserviceable material within a distance of 50 m.

The rate shall also include for temporary shoring for the safety of portions not required to be pulleddown,orofadjoiningproperty,andprovidingtemporaryenclosuresorpart itions,where considered necessary.

Roofs

Roof coverings generally including battens boarding, mats, bamboo jaffari or other subsidiary supportsshallbemeasuredinsqmtexceptleadsheetroofcovering,whichshallbem easuredin tonnes and stone slab roof covering which shall be measured in cum.

Ridges,hipsandvalleysshallbegirthedandincludedwiththeroofarea.Corrugated orsemi corrugated surfaces shall be measured flat and not girthed.

Mudphuskaonroofs shallbemeasuredin cum.

Leadsheetsinroofsshallbemeasuredintonnesandhips,valleys,flashings,liningto gutteretc. shall be included in this weight.

R.B. or R.C.C. roofs shall be measured in cum and if reinforcement is required to be salvaged, it shallbesostated.Whenreinforcementisrequiredtobeseparated,scrapedandclea ned,thework shall be measured separately as tonnes of salvaged steel. Supportingmembers,suchasrafters,purlins,beamsjoists,trussesetc.whereofwo odshallbe measured in cum and steel or iron sections in tonnes.

Ceiling

Thestrippingof ceilingsshallbemeasuredin sqm.

Dismantlingofsupportingjoists,beams,etc.shallbemeasuredin

cumorintonnes. Height above floor levels if it exceeds 3.5 m shall

paid for separately.

FlooringandPaving

Dismantlingoffloors(exceptconcreteandbrickfloors)shallbemeasuredinsqm.S upportssuch as joints, beams etc. if anyshall bemeasured as per Clause2.5. Concrete and bricks pavingshall be measured as per Clause 2.8.

ConcreteandBrickRoofsandSuspendedFloors

Demolitionoffloorsandroofsofconcreteorbrickshallbemeasuredincum.Beams cantilevers or other subsidiary supports of similar materials shall be included in the item. In measuring thickness of roofs provided with water proofing treatments with bitumen, felts, the thickness of water proofing treatment shall be ignored.

WallsandPiers

Taking down walls and independent piers or columns of brick, stone or concrete shall be measured,incum.Allcopings,corbels,cornicesandotherprojectionsshallbeincl udedwiththe wall measurements. Inmeasuringthicknessof plasteredwalls,thethickness ofplastershallbeignored.

Ashlarfacestones,dressedstonework,precastconcretearticles,etc.ifrequiredt obetaken down intact shall be so stated, and measured separately in cum.

Cleaningbricksstackingformeasurementsincludingallextrahandlingandremoval and disposing off the rubbish as stated shall be enumerated in thousand of cleaned bricks.

Cleaning stone obtained from demolished / dismantling stone masonry of any description includingashlarfacingdressedstonework,stoneslabsorflaggingandprecastconcreteblocks includingallextrahandlinganddisposingoftherubbishasstatedshallbe measuredincumof cleaned stone.

Honeycomb works orcavitywalls ofbricks stoneorconcrete shall bemeasured as solid.

ReinforcedConcreteandBrickWork

Reinforcedconcretestructuresandreinforcedbrickroofandwallsshallbemeasuredincumand if reinforcement is required to be salvaged, it shall be so stated.

Whereреinforcementisrequiredtobeseparated,scrapedandcleaned,theworkshallbe measured separately in tonnes of salvaged steel.

Partitions,TrellisWork,Etc.

Partitions or light walls of lath and plaster, trellis work, expanded metal, thin concrete or terracottaslabsandothersimilarmaterialsincludingframeworkifanyshallbemeasuredinsqm stating the overall thickness.

WoodWork

Allwoodworkincludingkarriesaverage40sqcmoroverinsection,shallbemeasuredincum, while that under 40 sq cm in section, in running metres. Ballies shall be measured in running metres. Boardingincludingwoodenchajjasandsunshadesalongwithsupportsshallbemeasuredin square m in its plane.

SteelandIronWork

Allsteelandironworkshallbemeasuredintonnes.Theweightshallbecomputedfrommstandard tables unless the actual weight can readily be determined.

Riveted work, where rivets are required to be cut, shall be measured separately. Markingofstructuralsteelrequiredtobere-erectedshallbemeasuredseparately.

In framed steel items, the weight or any covering material or filling such as iron sheets and expandedmetalshallbeincludedintheweightofthemainarticleunlesssuchcoverin gisnot ordered to be taken out separately.

Doorsand Windows

Dismantling of doors, windows, clerestory windows, ventilators etc. (Wood or metal) whether doneseparatelyoralongwithremovalofwallbymakingrecessinthewallshallbee numerated. Those exceeding 3 sqm each in area shall be measured separately. The item shall include removal of chowkhats architraves, hold fasts and other attachments.

Ifonlyshuttersaretobetakenout itshall bemeasured separately.

Pipes andSewer Lines

Waterpipelinesincludingrainwaterpipeswithclampsandspecials,sewerline s(saltglazed wareor concrete) etc. shall bedescribed bytheir diameterand length measured in runningm inclusive of joints.

Ifthejoints,specialandfittingsetc.arerequiredtobeseparated,itshallbesostateda nd enumerated.

Puccadrainsshallbemeasuredunderrelevantitems.

Valuecistern,public fountain platform,firehydrants, etc.shallbeenumerated.

Manholes and inspection chambers shall be enumerated stating the size and depth of manhole/inspectionchamber.Theyshallbeclassifiedintodifferentgroupsdepen dinguponthe depth, in unit of half and one m depth. Thedepth of themanhole shall be the distance between the top of manhole cover and invert level of the drain.

Ventilatingshafts,gullytraps,flushingcisternsandotherappurtenantitemso fworkshallbe enumerated.

Postsor Struts

Postsorstruts(wood,steelorRCC)sectionincludingtakingoutembeddedportions hallbe measured in running m.

FencingWireMesh

Wiremesh fencingofanytypewith frame shallbemeasured in squarem.

Glazing

Takingoutanyportionofserviceableglassexceptpolishedplate,fromoldsashes,skylights,etc. (any thickness, weight or size) raking out old putty, etc. shall be measured in square m.

Irregularorcircularpanesshallbemeasuredasrectangleorsquareenvelopingthesame,the width and height being measured correct to the nearest 0.5 cm.

DismantlingCulverts,BridgesandOtherStructures/Pavements

DismantlingCulvertsandBridges

Thestructuresshallbedismantledcarefullyandtheresultingmaterialssoremovedasnotto cause anydamage to the serviceable materials to be salvaged, the part of the structure to be retained and any other properties or structures nearby.

Unless otherwise specified, the superstructure portion of culverts / bridges shall be entirely removed and other parts removed below the ground level or as necessary depending upon the interferencetheycausetothenewconstruction.Removalofoverlayingoradjacent material,if required in connection with the dismantling of the structures shall be incidental to this item.

Where existing culvert / bridges are to be extended or otherwise incorporated in the new work, onlysuch part or parts of the exiting structure shall be removed as are necessaryand directed by the Engineer to provide a proper connection to the new work. The connectingedges shall be cut, chipped and trimmed to the required lines and grades without weakening or damaging any partof thestructureto beretained. Duecareshould be taken to ensurethat reinforcingbars which are tobeleftinplacetoprojectintothenewworkas dowelsortiesarenotinjuredduringremovalof concrete.

Pipeculvertsshallbecarefullyremovedinsuch mannerastoavoid damage

tothepipes.

Steelstructuresshall,unlessotherwiseprovided,becarefullydismantledinsucha mannerasto avoiddamagetomembersthereof. If specifiedin theDrawingsordirectedbytheEngineer that

thestructureistoberemovedinaconditionsuitableforre-erection,allmembersshallbematch- marked by the Contractor with white lead paint before dismantling; end pins, nuts, loose plates, etc., shall be similarlymarked to indicate their proper location; all pins, pin holes and machined surfaces shall be painted with a mixture of white lead and tallow and all loose parts shall be securely wired to adjacent members or packed in boxes.

Timberstructuresshallberemovedinsuchamannerastoavoiddamagetosuchtimberor lumber when designated by the Engineer to be salvaged.

DismantlingPavementsandOtherStructures

In removing pavements, kerbs, gutters and other structures like guard-rails, fences, manholes, catch-basins, inlets, etc. where portions of the existing construction are to be left in the finished work, the same shall be removed to an existing joint or cut and chipped to a true line with a face perpendiculartothesurfaceoftheexistingstructure.Sufficientremovalshallbemadetoprovide for proper grades and connections with the new work as directed by the Engineer.

Allconcretepavements,basecoursesincarriagewayandshouldersetc.,designatedforremoval shall broken to pieces whose volume shall not exceed 0.02 cum and stockpiled at designated locations if the material is to be used later or otherwise arranged for disposal as directed (see Clause 2.19.4).

Back-filling

Holesanddepressionscausedbydismantlingoperationsshallbebackfilledwithexcavatedor other approved materials and compacted to required density as directed by the Engineer.

DisposalofMaterials

All materials obtained bydismantlingshall be the propertyof Employer. Unlessotherwise specified, materials havinganysalvage value shall be placed in neat stacks of like materials withintheright-of-way,asdirected bytheEngineerwith allliftsandupto aleadof1000 m.

Pipeculvertsthatareremovedshallbecleanedandneatlypiledontheright-of-wayatpoints designated by the Engineer with all lifts and lead up to 1000 m.

Structural steel removed from old structures shall, unless otherwise

specified or directed, be storedinaneatandpresentablemanneronblocksinlocationssuitableforloading. Structuresor portions thereof which are specified in the Contract for re-erection shall be stored in separate piles.

Timber orlumber from old structures which is designated bytheEngineer as materials to be salvagedshallhaveallnailsandboltsremovedtherefromandshallbestoredin neatpilesin locations suitable for loading.

Allmaterialsobtainedfromdismantlingoperationswhich,intheopinionoftheEngineer,cannot be used or auctioned shall be disposed of as directed by the Engineer with all lifts and up to a lead of 1000 m.

MeasurementsforPayment

Theworkofdismantlingstructuresshallbepaidforinunitsindicatedbelowbytaking measurements before and after, as applicable:

1.	Dismantlingbrick/stonemasonry/ concrete(plainandreinforced)	cum.
2.	Dismantlingflexibleandcementconcretepavement	cum.
3.	Dismantlingsteelstructures	tonne
4.	Dismantlingtimberstructures	cum.
5.	Dismantlingpipes,guardrails,kerbs,guttersandfencing	linearm.
6.	Utilityservices	Nos.

Rates

TheContractunitratesforthevariousitemsofdismantlingshallbepaidinfullforcarryingout the required operations including full compensation for all labour, materials, tools, equipment, safeguards and incidentals necessary to complete the work. These will also include excavation and backfilling where necessaryto the required compaction and for handling, salvaging, piling and disposing of the dismantled materials within all lifts and up to a lead of 1000 m.

EndofSection-2

SECTION 3

EARTHWOR

KS

SECTION3

EARTHWORKS

ApplicableCodes

ThefollowingIndianStandardCodes,unlessotherwisespecifiedherein,shallbea pplicable. In all cases, the latest revision of the codes shall be referred to.

a) IS 783 - 1985 - CodeofpracticeforlayingofConcretepipes. (Reaffirmed 2017)
IS4984-1995- Codeofpracticeforlayingof HDPE pipes. (Reaffirmed2016)
IS 12288 - 1987 -

CodeofpracticeforuseandlayingofDIpipes. (Reaffirmed 2017)

b) IS 3764- 1992 - Excavationwork-
CodeofSafety. (Reaffirmed 2017)

c) IS 2720 - Methodsof test for soils:
(Part-1)- 1983 -

Preparationofdrysoilsamplesforvarioustests. (Reaffirmed 2015)
(Part-2)- 1973 - DeterminationofWaterContent. (Reaffirmed 2015)
(Part-4)- 1985 - Grainsizeanalysis. (Reaffirmed 2015)
(Part-5)- 1985 - Determinationofliquidandplasticlimit. (Reaffirmed 2015)
(Part-7)- 1980 - Determinationofwatercontent-drydensityrelation using light compaction. (Reaffirmed2016)
(Part-9)- 1992 - Determinationofdrydensity-moisturecontentby constant weight of soil method. (Reaffirmed2016)
(Part-14)- 1983- Determinationofdensityindex (relative density) Cohesionless soils. (Reaffirmed2015)
(Part-22) - 1972 -

Determinationoforganicmatter.

(Reaffirmed 2015)
(Part-26) - 1987 -

DeterminationofpHValue. (Reaffirmed 2016)
(Part-27)- 1977-

Determinationoftotalsolublesulphates. (Reaffirmed 2015)

(Part-28)- 1974-

Determinationofdrydensityofsoilsinplace,bythe sand replacement method.
(Reaffirmed2015)

(Part-33)-1971-

Determinationofthedensityinplacebytheringandwater replacement method.
(Reaffirmed2015)

(Part-34) - 1972-

Determinationofdensityofsoilinplacebyrubber balloon method.
(Reaffirmed2015)

(Part-38) - 1976-

Compactioncontroltest(HilfMethod).
(Reaffirmed 2016)

Drawings

Engineerwillfurnishdrawingswherever,inhisopinion,suchdrawingsarerequiredtoshow areas to be excavated/filled grade level, sequence of priorities etc.Contractor shall follow strictly such drawings.

General

TheContractorshallfurnishalltools,plant,instruments,qualifiedsupervisorypersonnel,labour, materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the work in accordance with the Specifications.

The Contractor shall surveythe site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches,pipelinesetc.Suchsurveyshallbecarriedoutbytakingaccuratecrosssectionsofthe area perpendicular to established reference/grid lines at 8m intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.

Theexcavationshallbecarriedouttocorrectlinesandlevels.Thisshallalsoinclude,where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.

The rates quoted shall also include for dumping of excavated material in regular heaps, bunds, riprap with regular slopes within the lead specified

and levelling the same so as to provide naturaldrainage.Rock/soilexcavatedshallbestackedproperlyasapprovedbytheEngineer.As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resistingmaterialsformingthecasingonthesidesandthetop.Rockshallbestackedseparately.

Topsoilshallbestockpiled separatelyforlaterre-use.

Clearing

The area to be excavated/filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation,rubbish,slush,etc.andotherobjectionablematter.Ifanyrootsorstumpsoftreesare encountered during excavation, they shall also be removed. The material so removed shall be disposedoffasapproved bytheEngineer.Whereearthfillisintended,theareashallbestripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

Classification

All materials to be excavated shall be classified by Engineer, into one of the following classes and shall be paid for at the rate tendered for that particular class of material.No distinction shall be made whether the material is dry, moist or wet.The decision of Engineer regarding the classification of the material shall be final and binding on Contractor and not be a subject matter of anyappeal or arbitration.

Anyearthwork will beclassified underanyof the followingcategories:

a) Ordinary&Hard Soils

These shall include all kinds of soils containing kankar, sand, silt, moorum and/or shingle, gravel, clay, loam,peat,ash,shale,etc.,whichcan generallybeexcavatedbyspade,pickaxesandshovel,and which is not classified under “soft and decomposed rock” and “hard rock” defined below.This shall also include embedded rock boulders not longer than 1 metre in any one direction and not more than 200 mm in any one of the other two directions.

b) SoftandDecomposedRock

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite, highly weathered granite gneissandallothermaterialswhichintheopinionofEngineerisrock,butdoesnotneedblasting and could be removed readily with picks, hammer, crow bars, wedges, and pneumatic breaking equipment.The mere fact that Contractor resorts to blasting for reasons of his own, shall not qualify for classification under ‘hard rock’.

This shall also include excavation in macadam and tarred roads and pavements.This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions.Masonry to be dismantled will also be measured under this item.

c) HardRock

This shall include all rock occurring in large continuous masses which cannot be removed except by blasting, chiselling or by drilling with heavy mechanical breakers. Harder varieties of rock with or without veins and secondary minerals which, in the opinion of Engineer require blasting shall be considered as hard rock.Boulders of rock occurring in such sizes and not classified under (a) and (b) above shall also be classified as hard rock.Concrete work both reinforced and unreinforced to be dismantled will be measured under this item, unless a separate provision is made in the Schedule of Quantities.

Before classification of material as rock the Contractor shall demonstrate to the satisfaction of the Employer's Representative his inability to excavate it without resort to heavy percussion toolscompletewithrockbits,hydraulicwedgesorblasting.Excavationbytheuseo fexplosive will not normally be permitted.

Material shall not be classified as rock unless the Employer's Representative has agreed to such classificationonthebasisofsuchademonstrationbeforeitsexcavation.Excavatio nswhererock has been encountered and classified as such shall not be backfilled before examination of the excavated faces bythe Employer's Representative to enable the extent of the rock excavation to be determined.

Excavation

Allexcavationworkshallbecarriedoutbymechanicalequipmentunless,inthe opinionof Engineer, the work involved requires it to be carried out by manual methods.

Excavationforpermanentworkshallbetakenout tosuchwidths,lengths,depthsandprofilesas are shown on the drawings provided by the Contractor or such other lines and grades as may be agreed with the Engineer. Rough excavation shall be carried out to a depth of 150mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed belowthefinallevelandextraexcavationfilledupwithleanconcreteofgradeM10 with20mm downgraded aggregates as approved bythe Engineer. The final

excavation should be carried out just prior to laying the blinding course.

Contractor may, for facility of work or similar other reasons excavate, and also backfill later, if soapprovedbyEngineer,athisowncostoutsidethelinesshownonthedrawingsor directedby Engineer.Shouldanyexcavation betakenbelowthespecifiedelevations,Contractorshallfill it

up,withconcreteofthesameclassasinthefoundationrestingthereon,uptothereq uired elevation.No extra shall be claimed by Contractor on this account.

All excavations shall be to the minimum dimensions required for safety and ease of working.
PriorapprovaloftheEngineershallbeobtainedbytheContractorineachindividua lcase,forthe
methodproposedfortheexcavation,includingdimensions,sideslopes,dewaterin g,disposal,etc. This approval shall not in anywayrelievethe Contractor ofhis responsibilityfor any consequent
lossordamage.Theexcavationmustbecarriedoutinthemostexpeditiousandeffic ientmanner. Side slopes shall be as steep as will stand safelyfor theactual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope.Removal of the slipped earth will not be paid for if the slips are due to the negligence of Contractor.

StrippingLoose Rock

All loose boulders, detached rocks partially and other loose material which might move
therewithnotdirectlyintheexcavationbutsoclosetotheareatobeexcavatedasto beliable,in the opinion of Engineer, to fall or otherwise endanger the workmen, equipment, or the work shall be stripped off and removed from the area of the excavation.The method used shall be such as not to render unstable or unsafe the portion which was originally sound and safe.

Anymaterialnotrequiringremovalinordertocompletethepermanent works,butwhich,inthe opinion of Engineer, is likely to become loose or unstable later, shall also be promptly and satisfactorilyremoved.The cost of such stripping will be paid for at the unit rates accepted for the class of materials in question.

ExcavationinHardRock

GeneralRequirements

Unless otherwise stated herein, I.S Specification "IS- 4081(1986) Safety code for Blasting and related Drilling Operations" shall be followed. After removal of overburden, if any, excavation shall be continued in rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. As far as possible all blasting shall be completed prior to commencement of construction.At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition.The quantity and strength of explosive usedshallbesuchaswill
neitherdamagenorcracktherockoutsidethelimitsofexcavation.All

precautions, as directed by the Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of the Engineer at his cost.As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Specific permission of the Engineer will have to be taken byContractor for blasting rock and he shall also obtain a valid Blasting Licence from the authorities concerned.If permission for blastingis refused bythe Engineer, therock shall be removed bywedging, pick, barring, heating andquenchingorotherapprovedmeans.Allllooseorloosenedrockinthesidesshall beremoved by barring, wedging, etc. The unit rate for excavation in hard rock shall include the cost of all these operations.

Contractorshallobtainnecessarylicenseforstorageofexplosives,fusesanddetonatorsissuedto him from Employer's stores or from supplier arranged by him, from the authorities dealing with explosives.The fees, if any, required for obtaining such license, shall be borne by Contractor.
Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Government authorities and Statutory bodies/regulations. Explosives shall be kept dryand shall not be exposed to direct rays of sun or be stored in the vicinityof fire, stoves,steampipesorheatedmetal,etc.Noexplosiveshallbebroughtnearthework inexcessof quantity required for a particular amount of firing to be done; and surplus left after filling the holesshallberemovedtothemagazine.Themagazineshallbebuiltasforaspossibleawayfrom the area to be blasted, Engineer's prior approval shall be taken for the location proposed for the magazine.

Innocaseshallblastingbeallowedcloserthan30metrestoanystructureortolocationswhere concrete has just been placed.In the latter case the concrete must be at least 7 days old.

Excavationinhardrockshallbeonlybychiseling/ Jackhammeringorbydrillingwith mechanical breakers.

Therockshallberemovedbywedging,pick,boring,heatingandquenchingorotherapproved non-blasting methods.All loose or loosened rock in the sides shall be removed by barring, wedging etc.The unit rate for excavation in hard rock shall include the cost of all these operations.No blasting is allowed.

SpecificRequirements

Forblastingoperations,thefollowingpointsshallbeobserved.

Contractorshallemployacompetentandexperiencedsupervisorandlicensedblasterin-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Beforeanyblastingiscarriedout,Contractorshall intimateEngineerandobtainhisapproval in writingforresortingtosuchoperations.Heshallintimatethehoursoffiringcharges,thenature of explosive to be used and the precautions taken for ensuring safety.

Contractor shall ensure that all workmen and the personnel at site are excluded from a area within200m.radiusfromthefiringpoint,atleast5minutesbeforefiringtimeb ysounding warningwhistle. Theareashall also begiven warningbysoundingadistinguishing whistle.

The blasting of rock near any existing buildings, equipment or any other property shall be done undercoverifpermittedbytheEngineerandContractorhastomakeallsuchnecessarymuffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them.Blasting shall be done with small charges only and where directed by Engineer, a trench shallhavetobecutbychiselingpriortotheblastingoperationseparatingtheareaunderblasting from the existing structures.

ThefiringshallbesupervisedbyaSupervisorandnotmorethan6(six)holesatatimeshallbe set off successively. If the blasts do not tallywith the number fired, the misfired holes shall be carefullylocated after half an hour and when located, shall be exploded bydrillinga fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.

A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammershallnotbepermitted.Thechargesshallbeplacedfirmlyintoplaceandnottrammedor pounded.After a hole is filled to the required depth, the balance of the hole shall be filled with stemming which may consist of sand or stone dust or similar inert material.

Contractorshall preferablydetonatethe explosives electrically.

Theexplosivesshallbeexplodedbymeansofaprimerwhichshallbefired bydetonatingafuse instantaneous detonator (F.I.D) or other approved cables. The detonators with F.I.D shall be connected by special nippers.

Indryweatherandnormaldryexcavation,ordinarylow explosivegunpowdermaybeused.In damp rock, high explosive like gelatine with detonator and fuse wire may be used.Under orforexcavationinrockwithsubstantialaccumulatedseepageelectricdetonationshallbe used.

Holes for charging explosive shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting. When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an overbreak limit of 75 mmshallbefilledupasinstructedbyEngineer,withconcreteofstrengthnotlessthanM10.The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stopping in rock excavation shall be done by hand trimming.

Contractorshallberesponsibleforanyaccidenttoworkmen,publicorEmployer's propertydue toblastingoperations.Contractorshallalsoberesponsibleforstrictobservanceofrules,laidby Inspector of Explosives, or any other Authority duly constituted under the State and /or Union Government.

Fill,BackfillingandSiteGrading

General

All fill material shall be subject to the Engineer's approval. If any material is rejected by Engineer, the Contractorshallremovethesameforthwithfromthesite.Surplusfillmaterialshallbedeposited/disposedoff as directed by Engineer after the fill work is completed.

Noearthfillshallcommenceuntilsurfacewaterdischargesandstreamshavebeenproperly intercepted or otherwise dealt with to the approval of the Engineer.

TheContractorshallnotcommencetheplacementofanyfillorbackfillatanylocationwithout the approval of the Engineer.

Material

Totheextentavailable,selectedsurplussoilsfromexcavationsshallbeusedasbackfill.Backfill material shall be free from lumps, organic or other foreign material. All lumps of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall make arrangements to bringsuch materialfromoutsideborrowpits.Thematerialandsourceshallbesubjecttothepriorapproval of the Engineer. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Top soil containing foreign material shall be removed. The materials so removed shall be disposed off as directed by Engineer. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist, at his cost.

Fillinginpitsandtrenchesaroundfoundationsofstructures,walls,etc.

As soon asthe work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc., shall be cleared of all debris and filled with earth in layersnotexceeding15cm,eachlayerbeingwatered,rammedandproperlyconsolidated,before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Engineer. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Engineer is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Engineer.

PlinthFilling

Plinth filling shall be carried out with approved material as described hereinbefore in layers not exceeding 15cm, watered and compacted with mechanical compaction machines. The Engineer may,however,permitmanualcompactionbyhandtamperswhereheissatisfiedthat mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified aboveto avoid settlement at alater stage. The finished level of the filling shall be trimmed to the level/slope specified.

Compaction of the plinth fill shall be carried out by means of 12 ton rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands andgravel,vibratoryrollersshallbeused.Asmallerweightrollermaybeusedonlyi fpermitted by the Engineer. As rolling proceeds, water sprinkling shall be done to assist consolidation.
Watershall not be sprinkled in caseof sandyfills.

Thethicknessofeachunconsolidatedfilllayercaninthiscasebeuptoamaximumof 300mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used and the approval of the Engineer obtained prior to commencing filling.

Rollingshall commence from theouteredgeand progress towards the centreand continueuntil compactionistothesatisfactionofEngineer,butinnocaselessthan10passesofth erollerwill be accepted for each layer.

Thecompactedsurfaceshallbeproperlyshaped,trimmedandconsolidatedtoane venand uniform gradient. All soft spots shall be excavated, then filled and consolidated.

Atsomelocations/
areas,itmaynotbepossibletouserollersbecauseofspacerestrictions,etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction.

SandFillinginPlinthandOtherPlaces

Where backfillingis required to be carried out with local sand it shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded conditionshallbeonContractor’saccount.Thesurfaceoftheconsolidatedsandsh allbedressed to required level or slope. Construction of floors or other

structures on sand fill shall not be started until the Engineer has inspected and approved the fill.

Fillingin Trenches

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drainshavebeentestedandpassed.Thebackfillingmaterialshallbeproperlyconsolidatedby watering and ramming, taking due care that no damage is caused to the pipes.

Wherethetrenchesareexcavatedinsoil,thefillingfromthebottomofthetrenchto thelevelof the centre line of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centre line of the pipes shall be done with selected earth byhand compaction, or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling upto a level 30 cm above the top of the pipe shall be done with fine materials such as earth, murum, etc.The filling up to the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the fillingabove the centreline of thepipe shall be done byhand compaction or approved means inlayersnotexceeding15cm.Thefillingfromalevel30cmabovethetopofthepipetothetop of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Fillingofthetrenchesshallbecarriedoutsimultaneouslyonbothsidesofthepipetoavoid unequal pressure on the pipe.

Inthecaseofwatertransmission,pipelinesworksetcforwatertransfer,theContractorshall take proper precautions against the risks of floatation.Should anysection of the pipeline be affected by floatation in the course of works the entire work shall be removed and then reinstalled to the satisfaction of Engineer.

GeneralSiteGrading

Site grading shall be carried out as indicated in the drawings and as approved by the Engineer. ExcavationshallbecarriedoutasspecifiedintheSpecifications.Fillingandcompactionshallbe carried out as specified under Clause 3.9 and elsewhere unless otherwise indicated below.

Thefillhastobecompactedinlayersnotexceeding225mmandleveleduniformlyand compacted as indicated in Clause 3.9 before the next layer is deposited.

Toensurethatthefillhasbeencompactedasspecified,fieldandlaboratorytestsshallbecarried out by the Contractor at his cost.

Fieldcompactiontestsshallbecarriedoutineachlayeroffillinguntilthefilltothee ntireheight has been completed.This shall hold good for embankments as well. The fill will be considered as incomplete if the desired compaction has not been obtained.

The Contractor shall protect the earth fill from beingwashed awaybyrain or damaged in any otherway.Shouldanyslipoccur,theContractorshallremovetheaffectedmaterialandmake good the slip at his cost.

If so specified, the rock as obtained from excavation may be used for filling and leveling to indicate grades without further breaking.In such an event, filling shall be done in layers not exceeding 50 cms approximately.After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids.Care shall be takentoensurethatthefinerfillmaterialdoesnot getwashedout.Overthelayersofilled,a100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 ton roller.No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

Fill Density

Thecompaction,wheresocalledfor,shallcomplywithminimum95%ModifiedProctordensity at moisture content differing not more than 4% from the optimum moisture content. The Contractor shall demonstrate adequately by field and laboratory tests that the specified density has been obtained.

Lead

Leadfordeposition/ disposalofexcavatedmaterial,shallbeasspecifiedintherespectiveitemof work. No extra compensation is admissible on the grounds that the lead including that for borrowed material had to be transported over marshy or ‘katcha’ land/route.

MeasurementandPayment

All excavation shall be measured net. Dimensions forpurpose of payment shall be reckoned on thehorizontalareaoftheexcavationatthebaseforfoundationsofthe walls,columns,footings, tanks, rafts or other foundations/structures to be built, multiplied by the mean depth from the surface of the ground in accordance with the drawings.Excavations in side slopes will not be paid for.Contractor may make such allowance in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety or excavation.Reasonable working space,beyondconcretedimensionsandshutteringwhereconsiderednecessaryintheopinionof Engineer will be allowed in excavation and considered for payment.However, if concreting is proposed against the excavated sides, no such over-excavation will be permitted.In such cases over-excavation shall be made good by Contractor with concrete of the same class as in the foundations at his cost.

Inthecaseofwatertransmission,pipelinesworksetcforwatertransfertrenchex cavationshall bemeasured usingthe dimensions detailed in thestandard section shown on the Drawings.No payment will be made for working space except where clearly mentioned on the drawings.
Excavationbeyondthewidthsordepthsrequiredwillnotbepaidforanyadditiona lconcreteor bedding material required as a result of over-excavation at the Contractor’s expense.

Backfilling as per specification the sides of foundations of columns, footings, structures, walls, tanks, rafts, trenches etc. with excavated material will not be paid for separately.It shall be clearlyunderstoodthattheratequotedforexcavationincludingbackfillingshallincludestacking of excavated material as directed, excavation/packing of selected stacked material, conveying it to the place of final backfill, compaction etc. as specified.As a rule material to be backfilled shall be stacked temporarily within the site as directed by the Engineer

Payment for fill inside trenches, plinth or similar fillingwith selected excavated material will be made for onlycompaction as specified/directed.Cost of all other operations shall be deemed to have been covered in the rate quoted for excavation.Payment for this work will be made based on measurement of plinth/trench dimensions as per drawings.The plinth ground levels shall be surveyedbeforehandforthispurpose.Ifnocompactionisspecified/desiredsuch fillingwillnot beseparatelypaidfor.In suchaneventthefillshallbeleveled/finishedtotheprofileasdirected at no extra cost.

Backfilling, plinth filling etc. with borrowed earth will be paid for at rates quoted.The quoted rate shall include all operations such as clearing, excavation, lead and transport, fill, compaction etc, as specified.Actual quantity of consolidated filling or actual quantity or excavation in the borrow pits (less such top soil which has been excavated and not used for filling) whichever is lessshallbemeasuredandpaidforincubicmeters.Thelead,liftetc.shallbeasindicatedinthe schedule of quantities.

Actualquantityof consolidated sandfillingshall bemeasuredand paid in cubic meters.

Volume of rock excavated shall be calculated on the basis of length, breadth and depth of excavation indicated on the drawings.No payment will be made for excavations/over break beyondpaymentlinespecified.Wheresuchmeasurementisnotpossibleasinthecaseofstrata intermixed with soil, excavated rock shall be properly stacked as directed by Engineer and the volume of rock calculated on the basis of stack measurements after making appropriate allowance forvoids.The allowance to be madefor voids shall be decided byEngineer and this will not be a subject matter of dispute or appeal.

TimberShoring

Closetimberingshallbedonebycompletelycoveringthesidesofthetrenchesandpitsgenerally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections or as approved by the Engineer. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal

walings of strong wood at maximum 1.2 meter spacing’s, strutted with ballies or as approved bythe Engineer.The length of the ballie struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walings, which in turn shall be suitablystrutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

Timbershoringshallbe'close'or'open'type,dependingonthenatureofsoilandthe depthofpit or trench. The type of timbering shall be as approved by the Engineer.It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc. from collapsing.

Timbershoringmayalso berequiredtokeepthesidesofexcavationsverticaltoensuresafetyof adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons.Suchshoringshallbecarriedout,except inanemergency,onlyunderinstructionsfrom the Engineer.

Thewithdrawalofthetimbershallbedonecarefullytopreventthecollapseofthep itortrench. It shall be started at one end and proceeded with, systematically to the other end.Concrete or masonry shall not be damaged during the removal of the timber.

In the caseof open timbering, the entiresurfaceof the sideof trench or pit is not required to be covered.The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50cm average width. The detailed arrangement, sizesofthetimberandthespacingsshallbesubjecttotheapprovaloftheEngineer. Inallother respects, the Specifications for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bedshallbeprovided.Theloadfromsuchstrutsshallbesuitablydistributedontheb edtoensure no yielding of the strut.If however, Engineer directs anytimbering to be left-in, keeping in mind the type of construction or any otherfactor,Contractorshallbepaidforattheschedule ditemrateforsuchleft-intimbering.

Measurement

Unless separately provided for in the Schedule of Quantities, the actual effective area of shored facesasapprovedbyEngineershallbemeasuredinsq.m.Theareaofplankingemb eddedinthe bed/sides of excavation will not be considered, nor the area supporting inclined struts in case of large pits/open excavation.All planks, boards, walings, verticals, struts, props and all other materials required for shoring and subsequent safe dismantling and removal shall be included in the quoted unit rates.

Dewatering

The Contractor shall ensure that the excavation and the structures are free

from water during constructionandshalltakeallnecessaryprecautionsandmeasurestoexcludegro und/rainwater so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. The method of pumping shall be approved by Engineer, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping

arrangementsshallbeadequatetoensurenodelaysinconstruction.Thedewa teringshallbe continuedforatleast(7)sevendaysafterthelastpourofthe concrete.TheContractorshall, however, ensure that no damage to the structure results on stopping of dewatering.

TheContractorshallstudythesub-soilconditions carefullyandshallconductanytestsnecessary at the site with the approval of the Engineer to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

The scheme for dewatering and disposal of water shall be approved by the Engineer. The Contractor shall suitablydivert the water obtained from dewatering from such areas of site whereabuildupofwaterintheopinionoftheEngineerobstructstheprogressofthe work,leads to insanitaryconditions bystagnation, retards thespeed of construction and is detrimental to the safety of men, materials, structures and equipment.

Whenthereisacontinuousinflowofwaterandthequantumofwatertobehandledis considered in the opinion of Engineer, to be large, a well point system-single stage or multistage, shall be adopted. The Contractor shall submit to the Engineer, details of his well point system including the stages, the spacing, number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval. Unless separately provided for in the Schedule of prices, the cost of dewatering shall be included in the item rate for excavation.

Measurement

UnlessseparatelyprovidedforintheScheduleofquantities,dewateringisdeeme dtohavebeen included in the unit rates quoted for excavation.If separately provided for, the unit of measurement shall be as indicated in the Schedule of Quantities.

RainWater Drainage

Gradinginthevicinityofexcavationshallbesuchastoexcluderain/ surfacewaterdraininginto excavated areas. Excavation shall be kept clean of rain and such water as the Contractor maybe using for his work bysuitablypumpingout the same. The scheme for pumping and discharge of such water shall be approved by the Engineer.

EarthenEmbankmentConstruction

Scope

TheseSpecificationsshallapplytotheconstructionofembankmentsincluding subgrades, earthen shoulders and miscellaneous backfills with approved

materials obtained from roadway and drain excavation, borrow pits or other sources. All embankments, subgrade, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these Specifications and in conformity with the lines, grades, and cross- sections shown on the Drawings or as directed by the Engineer.

PhysicalRequirementsofmaterials

The materials used in embankments, sub grades, earthen shoulders and miscellaneous backfillsshallbesoil,moorum,gravel,amixtureofthoseoranyothermaterialapprovedby the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/subgrade.

Thefollowingtypesofmaterialshallbeconsideredunsuitableforembankment: Materials from swamps, marshes and bogs. Peat,log,stumpandperishablematerialanysoilthatclassifiesasOL,OI,OHorPt in accordance with IS: 1498.

Materialssusceptibletospontaneouscombustion. Materialsinfrozenconditions. Clayhavingliquidlimitexceeding70andplasticityindexexceeding45and Materials with salts resulting in leaching in the embankment.

Expansive clay exhibiting marked swell and shrinkage properties (“free swelling index” exceeding50percentwhentestedasperIS:2720Part40)shallnotbeusedasafill material. Where expansive clay with acceptable “free swelling index” value is used as a fill material, subgrade and top 500 mm portion of the embankment just below subgrade shall be non- expansive in nature.

Anyfill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed asSO3)perlitrewhentestedinaccordancewithBS:1377Test10,butusinga2:1 water-soil ratio shall not be deposited within 500 mm or other distance described in the Contract, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works.

Materialswithatotalsulphatecontent(expressedasSO3)exceeding0.5per centbymass, whentestedinaccordancewithBS:1377Test9shallnotbedepositedwithin 500mm,or otherdistances described in theContract, of metallicitems formingpart of the Permanent Works.

The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm when being placed in the embankment and 50 mm when placed in the subgrade. However, the Engineer may at his discretion permit the use of material coarser than this also if he is satisfiedthatthesamewillnotpresentanydifficultyasregardstheplacementoffillmaterial and its compaction to the requirements of these Specifications. The maximum particle size shall not be more than two-thirds of the compacted layer thickness.

Ordinarily,onlythematerialssatisfyingthedensityrequirementsgiveninTableIshallbe employed for the construction of the embankment and

the subgrade.

Table-I.DensityRequirementsofEmbankmentandSubgradeMaterials

Sr.	TypeofWork	Maximumlaboratorydryunit weightwhentestedasperIS:2270 (Part 8)
1.	Embankmentsupto3metersheight, not subjectedto extensiveflooding.	Not less than 15.2 kN/cum.
2.	Embankmentsexceeding 3meters height orembankmentsofanyheightsubjectto long periods of inundation	Not less than 16.0 kN/cum.
3.	Subgradesandearthenshoulders/ verges/ backfill	Not less than 17.5 kN/cum.

Notes: This Table is not applicable for lightweight fill material e.g. cinder, flyashetc.

TheEngineermayrelaxtheserequirementsathisdiscretiontakingintoaccountthe availability of materials for construction and other relevant factors.

ThematerialtobeusedinsubgradeshouldalsosatisfydesignCBRatthedryunitweight applicable as per Table-II.

Generalrequirementsof materials

Thematerialsforembankmentshallbeobtainedfromapprovedsourceswithpreference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

Theworkshallbesoplannedandexecutedthatthebestavailablematerialsaresavedforthe subgrade and the embankment portion just below the subgrade.

BorrowMaterials

Where the materials are to be obtained from designated borrow areas, the location, size and shape of these areas shall be as indicated by the Engineer and the same shall not be opened without his written permission. Where specific borrow areas are not designated by the Employer / the Engineer, arrangement for locating the source of supply of material for embankmentandsubgradeaswellascompliancetoenvironmentalrequirementsinrespectof excavation and borrow areas as stipulated, from time to time bythe Ministryof Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Borrowpitsalongtheroadshallbediscouraged.

IfpermittedbytheEngineer,theseshallnot be dug continuously. Ridges of

not less than 8 m width should be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges to facilitate drainage. The depthofthepitsshallbesoregulatedthattheirbottomdoesnotcutanimaginary linehaving a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit shall be dug within the

offsetwidthfromthetoeoftheembankmentrequiredaspertheconsiderationo fstability with a minimum width of 10 m. Haulageofmaterialtoembankmentsorotherareasoffillshallproceedonlywhen sufficient spreading and compaction plants is operating at the place of deposition.

NoexcavatedacceptablematerialotherthansurplustorequirementsoftheCo ntractshallbe removed from the site. Should the Contractor be permitted to remove acceptable material from the site to suit his operational procedure, then he shall make good any consequent deficit of material arising there from.

Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed bythe Engineer, carryout the excavation in such a mannerthattheacceptablematerialsareexcavated separatelyforuseinthepermanentworks without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fillsbythemethodsofstockpilingmaterials,useofplantsorsitingoftemporary buildingsor structures.

TheContractorshallobtainrepresentativesamplesfromeachoftheidentified borrowareas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the subgrade material when compacted to the density requirements as in Table II shall yield the design CBR value of the subgrade.

Table-II.CompactionRequirementsforEmbankmentandSubgrade

Sr	Typeofwork/material	Relativecompactionaspercentageof max. laboratorydrydensityasperIS: 2720(Part 8)
1.	Subgradeandearthen shoulders	Not less than 97
2.	Embankment	Not less than 95
3.	Expansive Clays	
	a)Subgrade and500mm portion just below thesubgrade	Not allowed
	b)Remainingportion of embankment	Not less than 90

TheContractorshallatleast7workingdaysbeforecommencementofcompac tionsubmit the following to the Engineer for approval:

The values of maximum dry density and optimum moisture content obtained in accordance withIS:2720(Part7)or(Part8),asthecasemaybe,appropriateforeachofthefill materials he intends to use.
Agraphofdensityplottedagainstmoisturecontentfromwhicheachofthevalue sin(1) above of maximum dry density and optimum moisture content were determined.

The Dry density-moisture content-CBR relationships for light, intermediate and heavy compactiveefforts(lightcorrespondingtoIS:2720(Part7),heavycorrespondingtoIS:2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the subgrade.

Oncetheaboveinformationhasbeenapprovedbytheengineer,itshallformthebasisfor compaction.

ConstructionOperationsforEmba

nkments Setting out

After the site has been cleared to Section-1, the work shall be set out. The limits of embankment/subgradeshallbemarkedbyfixingbatterpegsonbothsidesatregularintervals as guides before commencing the earthwork. The embankment / subgrade shall be built sufficiently wider than the design dimension so that surplus materials may be trimmed, ensuring that the remaining material is to the desired density and in position specified and conforms to the specified side slopes.

Dewatering

If the foundation of the embankment is in an area with stagnant water, and in the opinion of theEngineeritisfeasibletoremoveit,thesameshallberemovedbybailingoutor pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry.
Care shall be taken to discharge the drained water so as not to cause damage to the works, cropsoranyotherproperty.Dueto anynegligenceonthepartoftheContractor,ifanysuch damage is caused, it shall be the sole responsibility of the Contractor to repair / restore it to original condition or compensate the damage at his own cost. If the embankment is to be constructed under Water, Clause 3.19.5 shall apply.

StrippingandStoringtopsoil

In localities where most of the available embankment materials are not conducive to plant growth,orwhensodirectedbytheEngineer,thetopsoilfromallareasofcuttingandfromall areas to be covered by embankment foundation shall be stripped to specified depths not exceeding 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired.
Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile.
Stockpilesshallnotbesurchargedorotherwiseloadedandmultiplehandlingshallbekeptto a minimum.

CompactinggroundsupportingEmbankment/Subgrade

Whennecessary,theoriginalgroundshallbeleveledtofacilitateplacementoffirstlayerof embankment, scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in Table-II.

In case where the difference between the subgrade level (top of the subgrade on which pavement rests) and ground level is less than 0.5 m and the ground does not have97 percent relative compaction with respect to the dry density as given in Table-I, the ground shall be loosened up to a level 0.5 m below the subgrade level, watered and compacted in layers in accordancewithClause3.19.4tonotlessthan97percentofdrydensityas giveninTable-II.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundationshallberemovedandreplacedbyapprovedmaterialslaidinlayerstot herequired degree of compaction.

Embankment or subgrade work shall not proceed until the foundations of embankments/subgradehavebeeninspectedbytheEngineerforsatisfactoryco nditionand approved.

Anyfoundationtreatmentspecifiedforembankmentsespeciallyhigh embankments,resting on suspect foundations as revealed byborehole logs shall be carried out in a manner and to thedepthasdesiredbytheEngineer.Wherethegroundonwhichembankmenti stobebuilt has any of the material types specified in Clause 3.19.2, at least 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

Spreadingmaterialinlayersandbringingtoappropriatemoisture content

The embankment and subgrade material shall be spread in layers of uniform thickness not exceeding200mmcompactedthicknessovertheentirewidthofembankmentb ymechanical means, finished by a motor grader and compacted as per Clause 3.19.4. The motor grader bladeshall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer underconstructionhasbeenthoroughlycompactedtothespecifiedrequireme ntsasinTable- II and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such construction, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surfaces but without any flooding. The water shallbeaddeduniformlyandthoroughlymixedinsoilbyblading,discingorharr owinguntil and uniform moisture content is obtained throughout the depth of the layer.

Ifthe;materialdeliveredtotheroadbedistoowet,itshallbedried,byaerationan dexposure to the sun, till the; moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, compaction work shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS: 2720 (Part 2), and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses,thatatthetimeofcompactionitisintherangeof1%aboveto2%belowthe optimum moisture content determined in accordance with IS: 2720 (Part 7) or IS: 2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed bymeans of graders, harrows,rotarymixersorasotherwiseapprovedbytheEngineeruntilthelayeris uniformly wet.

Clodsorhardlumpsofearthshallbebrokentohaveamaximumsizeof75mmwh enbeing placed in the embankment and a maximum size of 50 mm when being placed in the subgrade.

Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular trafficshallbemadegoodbytheContractorwithmaterialhavingthesamechar acteristics and strength as the material had before it was damaged.

Embankmentsandotherareasofunsupportedfillsshallnotbeconstructedwiths teeperside slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks faceincludingembankments,cuttings,otherfillsandexcavationssteeperthan 1verticalon4 horizontal, such faces shall be benched as per Clause 3.19.5 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineerbytrackingatrackedvehicle,consideredsuitablebytheEngineer,on theslopeor any other method approved by the Engineer.

Compaction

Onlythecompactionequipmentapprovedbytheengineershallbeemployedtocompactthe different material types encountered during construction. Smooth wheeled, vibratory, pneumatictyred,sheepfootorpadfootrollers,etc.,ofsuitablesizeandcapacityasapproved

bytheEngineershallbeusedforthedifferenttypesandgradesofmaterialsrequiredto be compacted either individually or in suitable combinations.

Thecompactionshallbedonewiththehelpofvibratoryrollerof80to100kNstaticweight withplainorpadfootdrumorheavypneumatictyredrollerofadequatecapacitycapableof achieving required compaction.

The Contractor shall demonstrate the efficiency of the equipment he intends to use by carryingoutcompactiontrials.Theproceduretobeadoptedforthesesitetrials shallfirstbe submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lightercategoryofplanttoprovideanypreliminarycompactiontoassisttheuseofheavier plant be taken into account.

Eachlayerofthematerialshallbethoroughlycompactedtothedensitiesspecifiedin Table-I. Subsequent layers shall be placed only after the finished layer has been tested according to Clause 903.2.2 of MORTH Specifications for Roads and Bridge Works (V Revision) and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture / density gauge used in accordance with agreed procedure and the gauge is calibratedtoprovideresultsidentifiedtothatobtainedfromtestsinaccordance with IS:2720 (Part 28). A record of the same shall be maintained by the Contractor.

When density measurement reveal any soft areas in the embankment / subgrade / earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspite of that the specified compaction is not achieved, the material in the soft areas shall be removed andreplacedbyapprovedmaterial,compactedtothedensityrequirementsand satisfactionof the Engineer.

Drainage

The surface of the embankment / subgrade at all times during construction shall be maintainedatsuchacrossfall(notflatterthanthatrequiredforeffectivedrainageofan earthen surface) as will shed water and prevent ponding.

Repairingofdamagescausedbyrain/spillageof water

The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small

vibratory roller, plate compactor or power rammer to achieve the requireddensityinaccordancewithClause3.19.5. Ifthecutisnotsufficientlywideforuse ofrequiredmechanicalmeansforcompaction,thesameshallbewidenedsuitablytopermit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages

includingwideningofthecut,ifany,shallbecarriedoutbytheContractorathisown cost, including the arranging of machinery / equipment for the purpose.

Finishingoperations

Finishing operations shall include the work of shaping and dressing the shoulders / verge / roadbed and sideslopestoconformtothealignment,levels,cross-sectionsanddimensionsshownontheDrawingsor as directed by the Engineer subject to the surface tolerance described in **Clause 902** of MORTH Specifications for Roads and Bridge Works (V Revision). Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The topsoil, removed and conserved earlier shall be spread over the fill slopes as per directions of the Engineertofacilitatethegrowthofvegetation.Slopesshallberoughenedandmoisteneds lightlypriorto the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 150 mm.

Wheredirected,theslopesshallbeturfedwithsodsinaccordancewith **Clause3.20**.Ifseedingand mulching of slopes is prescribed, this shall be done to the requirement of **Clause 3.21**.

Whenearthworkoperationshavebeensubstantiallycompleted,theroadareashallbeclear edofalldebris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

ConstructionofEmbankmentandSubgradeunderSpecial Conditions

Earthworkforwideningexistingroad embankment

Whenanexistingembankmentand/ orsubgradeistobewidenedanditsslopearesteeperthan 1vertical on4horizontal,continuoushorizontalbenches,eachatleast 300mmwide,shall becutintotheoldslope for ensuring adequate bond with the fresh embankment / subgrade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment / subgrade. However,whentheexistingslopeagainstwhichthefreshmaterialistobeplacedisflattert

han1vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of small vibratory rollers / plate compactors / power rammers of any other appropriate equipment approved by the Engineer. End dumping of material from trucksforwideningoperationsshallbeavoidedexceptindifficultcircumstanceswhenthe extrawidthis too narrow to permit the movement of any other types of hauling equipment.

Earthworkforembankmentandsubgradetobeplacedagainstsloping ground:

Whereanembankment/ subgradeistobeplacedagainstslopingground,thelattershallbeappropriately benched or ploughed / scarified as required in **Clause 3.19.5** before placing the embankment / subgrade material. Extra earthwork involved in benching or due to ploughing / scarifying etc. shall be considered incidental to the work.

Forwetconditions,bencheswithslightlyinwardfallsubsoildrainsatthelowestpointshal lbeprovided as per the Drawings, before the fill is placed against sloping ground.

Earthworkoverexistingroadsurface:

Wheretheembankmentistobeplacedoveranexistingroadsurface,theworkshallbecarrie doutas indicated below:

If the existing road surface is of granular or bituminous type and lies within 1 m of the new subgrade level,thesameshall bescarifiedtoadepthof50mmormoreifspecified,soastoprovideamplebond betweentheoldandnewmaterialensuringthatatleast500mmportionbelowthetop ofnewsubgrade level is compacted to the desired density.

Iftheexistingroadsurfaceisofcementconcretetypeandlieswithin1mofthenewsubgrad elevelthe same shall be removed completely.

Iftheleveldifferencebetweentheexistingroadsurfaceandthenewformationlevelismoret han1m,the existing surface shall be permitted to stay in place without any modification.

Embankmentandsubgradearound structures:

To avoid interference with the construction of abutments, wing walls or return walls of culvert / bridge structures,theContractorshall,atpointstobedeterminedbytheEngineersuspendworkon embankment forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures up to a distance of twicetheheight oftheroadfromthebackoftheabutment shall becarriedoutindependent oftheworkon the main embankment. The fill material shall not be placed against any abutment or wing wall, unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days.

Theembankment and subgrade shall bebrought up simultaneouslyinequal layerson each side of the structuretoavoiddisplacementinequallayersoneachsideofthestructuretoavoiddis placementand unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS: 2720 (Part 5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in Appendix 6 of IRC:78 (Standard Specifications and Code of Practice for Road Bridges-Section VII) in respectofthetypeofmaterial,theextentofbackfill, itslayingandcompactionetc.Thefillmaterialshall be deposited in horizontal layers in loose thickness and compacted thoroughly to the requirements of **Table-II.**

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirementsforfiltermediumspeltoutin **Clause2502**ofMORTHSpecificationsforRoadsandBridge Works (V Revision) unless otherwise specified in the Contract.

Where it may be impracticable to use conventional rollers, the compaction shall be carried out by

appropriatemechanicalmeanssuchassmallvibratoryroller,platecompactororpowerrammer.Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

ConstructionofEmbankmentoverGroundIncapableofSupportingConstruction Equipment:

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if sodesiredbyhim,mayalsousesuitablegeosyntheticmaterialtoincreasethebearingcapacityof the foundation. This exception to normal procedure will not be permitted where, in the opinionof the Engineer, the embankments could be constructed in the approved manner over such ground bythe use of lighter or modified equipment after proper ditchingand drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contract will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 3.19.4.

Embankmentconstructionunderwater

Wherefillingorbackfillingistobeplacedunderwater,onlyacceptablegranularmaterialorrock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall consist of graded, hard durable particles with maximum particle size not exceeding 75 mm. The material should be non-plastic having uniformity coefficient of not less than 10. The material placed in open water shall be deposited by end tipping without compaction.

Earthworkforhighembankment

In the case of high embankments, the Contractor shall normally use the material from the specified borrow area. In case he desires to use different material for his own convenience, he shall have to carry outnecessarysoilinvestigationsandredesignthehighembankmentathisowncost.TheContractorshall then furnish the soil test data and design of high embankment for approval of the Engineer, who reserve the right to accept or reject it.

Ifnecessary,stageconstructionoffillsandanycontrolledratesoffillingshallbecarriedo

utin accordance with the Contract including installation of instruments and its monitoring.

Whererequired,theContractorshallsurchargeembankmentsorotherareasoffillwithapprovedmaterial

for the periods specified in the Contract. If settlement of surcharged fill results in any surcharging material, which is unacceptable for use in the fill being surcharged, lying below formation level, the ContractorshallremovetheunacceptablematerialanddisposeitasperdirectionoftheEngineer.Heshall then bring the resultant level up to formation level with acceptable material.

Settlementperiod

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for abutment, wingwall, retaining wall, footings,etc.,ordrivingfoundationpiles.Thedurationoftherequiredsettlement periodateach location shall be as provided for in the Contract or as directed by the Engineer.

3.19.6
PlyingofTraffic

Construction and other vehicular traffic shall not use the prepared surface of the embankment and/orsubgradewithoutthepriorpermissionoftheEngineer.Anydamagearising outofsuch use shall, however, be made good by the Contractor at his own expense as directed by the Engineer.

3.19.7
SurfaceFinishandQualityControlofWork

The surface finish of construction of subgrade shall conform to the requirements of Clause 902 of MORTH Specifications for Roads and Bridge Works (V Revision). Control on the quality of materialsandworksshallbeexercisedinaccordancewithClause903ofMORTHSpecifications for Roads and Bridge Works (V Revision).

3.19.8
SubgradeStrength

Itshallbeensuredpriortoactualexecutionthattheborrowareamaterialtobeused inthe subgrade satisfies the requirements of design CBR.

Subgrade shall be compacted and finished to the design strength consistent

with other physical requirements. The actual laboratory CBR values of constructed subgrade shall be determined on undisturbedsamplescutoutfromthecompactedsubgradeinCBRmouldfittedwithcuttingshoe or on remoulded samples, compacted to the field density at the field moisture content.

3.19.9
MeasurementsforPayment

Earthembankment/
subgradeconstructionshallbemeasuredseparatelybytakingcrosssectionsat intervalsintheoriginalpositionbeforetheworkstartsandafteritscompletionandc omputingthe volumes of earthwork in cubic metres by the method of average end areas.

The measurement of fill material fromborrow areas shall be the difference between the net quantities of compactedfillandthenetquantitiesofsuitablematerialbroughtfromroadwayanddrain ageexcavation. For this purpose, it shall be assumed that one cum. of suitable material brought to site from road and drainage excavation forms one cum. of compared fill and all bulking or shrinkage shall be ignored.

Constructionofembankmentunderwatershallbemeasuredincum.

Constructionofhighembankmentwithspecifiedmaterialandinspecifiedmannershallb emeasuredin cum.

Strippingincludingstoringandreapplicationoftopsoilshallbemeasuredincum.

Workinvolvinglooseningandrecompactingofgroundsupportingembankment/ subgradeshallbe measured in cum.

Removalofunsuitablematerialatembankment/subgrade foundationandreplacementwithsuitable material shall be measured in cum.

Scarifyingexistinggranular/bituminousroadsurfaceshallbemeasuredinsquaremetres.

Dismantlingandremovalofexistingcementconcretepavementshallmeasuredvide Clause 202.6of MORTH Specifications for Roads and Bridge Works (V Revision).

Filtermediumandbackfillmaterialbehindabutments,wingwallsandotherretainingstructuresshallbe measured as finished work in position in cum.

3.19.10
Rates

TheContractunitratesfortheitemsofembankmentandsubgradeconstructionshallbepaymentinfull for carrying out the required operations including full compensation for:

Costofarrangementoflandasasourceofsupplyofmaterialofrequiredquantityforconstructionunless provided otherwise in the Contract;

Settingout;

Compactinggroundsupportingembankment/ subgradeexceptwhereremovalandreplacementof unsuitable material or loosening and recompacting is involved;

Scarifyingorcuttingcontinuoushorizontalbenches300mmwideonsideslopesofexistingembankment and subgrade as applicable;

Costofwateringordryingofmaterialinborrowareasand/ orembankmentandsubgradeduring construction as required.

Spreadinginlayersbringingtoappropriatemoisturecontentandcompactingto Specification requirements;

Shapinganddressingtopandslopesoftheembankmentandsubgradeincludingroundingo

fcorners; Restricted working at sites of structures;

Workingonnarrowwidthofembankmentand subgrade;

Excavationinallsoilsfromborrowpits/ designatedborrowareasincludingclearingandgrubbingand transporting the material to embankment and subgrade site with all lifts and leads unless otherwise provided for in the Contract;

All labour, materials, tools, equipment and incidentals necessary to complete the work to the Specifications,DewateringandKeepingtheembankment/completedformationfreeofwater.Incasethe Contract unit rate specified is not inclusive of all leads, the unit rate for transporting material beyond the initial lead, as specified in the Contract for construction of embankment and subgrade shall be inclusive of full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the specified initial lead.

TheContractunitratefortheitemsofstrippingandstoringtopsoilandofreapplicationoftopsoilshall include full compensation for all the necessary operations including all lifts, but leads up to 1000 m.

TheContractunitrateforlooseningandrecompactingtheloosenedmaterialsatsubgradeshallinclude full compensation for loosening to the specified depth, including breaking clods, spreading in layers, watering where necessary and compacting to the requirements.

The Contract unit rate for scarifying existing granular / bituminous road surface shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. This will also comprise of handling, salvaging,stackinganddisposingofthedismantledmaterialswithinallliftsanduptoaleadof1000mor as otherwise specified.

Clause202.7ofMORTHSpecificationsforRoads andBridgeWorks(VRevision)shallapplyasregards Contract unit rate for dismantling and removal of existing cement concrete pavement.

The Contract unit rate for providing and laying filters material behind abutments shall be payment in full forcarryingoutthe requiredoperationsincludingallmaterials,labour,tools,equipmentandincidentalsto complete the work to Specifications.

Clause3.19.5shallapplyasregardsContractunitrateforconstructionofembankmentunder water.

Clause 3.19.5 shall apply as regards Contract unit rate for construction of high embankment. It shall includecostofinstrumentation,itsmonitoringandsettlementperiod,wherespecifiedintheContractor directed by the Engineer.

SoilErosionandSedimentationControl

3.20.1
Scope

This work shall consist of measures as shown on plans or as directed by the Engineer to control soil erosion,sedimentationandwaterpollution,throughuseofberms,dikes,sedimentbasins ,fibremats, mulches, grasses, slope drains, and other devices.

3.20.2
Materials

Allmaterialsshallmeetcommercialgradestandardsandshallbeapprovedbytheengineer beforebeing used in the work.

3.20.3
ConstructionOperations

Prior tothe start ofthe relevant construction,the Contractor shall submittothe Engineerforapprovalhis schedules for carrying out temporary and permanent erosion / sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment / subgradeconstruction,bridgesandotherstructuresacrosswatercourse,pavementcou rsesandshoulders. He shall alsosubmit forapproval his proposed methodof erosion/ sedimentationcontrolon serviceroad and borrowpits and his plan for disposal of waste materials. Work shall not be started until the erosion / sedimentation control schedules and methods of operations for the applicable construction have been approved by the Engineer.

The surface area of erodible earth material exposed byclearingand grubbing, excavation, borrow and fill operationsshallbelimitedtotheextentpracticable.TheContractormaybedirectedtoprovi deimmediate permanent or temporary erosion and sedimentation control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of nearbystreams or other water courses, lakes, reservoirs etc. Suchwork may involve the construction of temporary berms, dikes, sediment basins, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation. Cut and fill slopes shall be seeded and turfed as required on the plans.

TheContractorshallberequiredtoincorporatedallpermanenterosionandsedimentation controlfeatures into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures.

Temporary erosion / sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal construction practices,butmayneitherbeforeseenduringdesignstagenorassociatedwithpermanent controlfeatures on the Project.

Where erosion or sedimentation is likely to be a problem, clearing and grubbing operations should be so scheduledandperformedthatgradingoperationsandpermanenterosionorsedimentation controlfeatures can follow immediately thereafter if the project conditions permit; otherwise temporary erosion or sedimentation control measure may be required between successive construction stages. Under no conditions shall a large surface area of erodible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the Engineer.

The Engineer may limit the area of excavation, borrow and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seedingandothersuchpermanenterosion,sedimentationandpollutioncontrolmeasures,inaccordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion/ sedimentationcontrol measures shall betakenimmediatelytotheextent feasibleandjustified.

In the event temporary erosion, sedimentation and pollution control measures become necessary due to theContractor'snegligence,carelessnessorfailuretoinstallpermanentcontrolsasapartoftheworkas scheduled or ordered by the Engineer, these shall be carried out at the Contractor's own expense. Temporaryerosion,sedimentationandpollutioncontrolworkrequired,whichisnotattributedtothe Contractor's negligence, carelessness of failure to install permanent controls, will be performed as ordered by the Engineer.

Temporaryerosion,sedimentationandpollutioncontrol mayincludeconstructionworkoutsidetheright-of-waywheresuchworkisnecessaryasresultofroadconstructionsuchasborrowpitoperations,service roads and equipment storage sites.

Thetemporaryerosion,sedimentationandpollutioncontrolfeaturesinstalledbytheContractorshallbe acceptably maintained by him till these are needed, unless otherwise agreed by the Engineer.

3.20.4
MeasurementsforPayment

Thesoilerosion,sedimentationandpollutioncontrolworkswillbemeasuredintermsofu nitsspecified in the Bill of Quantities for the respective items.

3.20.5
Rates

Thecontractunitratefordifferentitemsofsoilerosion,sedimentationandpollutioncontr olworksshall be payment in full for carrying out all required operations including full compensation for all labour, tools, equipment and incidents to complete the works to the Specifications.

TurfingwithSods

3.21.1
Scope

This work shall consist of furnishing and laying of the live sod of perennial turf forming grass on embankmentslopes,verges(earthenshoulders)orotherlocationsasdirectedbytheEngin eer.Unless otherwise specified, the work shall be taken up as soon as possible following construction of the embankment, provided the season is favorable for establishment of the sod.

3.21.2
Materials

Thesodshallconsistofdense,well-rootedgrowthofpermanentanddesirablegrasses,indigenoustothe localitywhereitistobeuse,andshall bepracticallyfreefromweedsor otherundesirablematter.Atthe time the sod is cut, the grass on the sod shall have a length of approximately 50 mm and the sod shall have freed of debris.

Thicknessofthesodshallbeasuniformaspossible,withsome50-80 mmorsoofsoilcoveringthegrass roots depending on the nature of the sod, so that practically all the dense root system of the grasses is retained in the sod strip. The sods shall be cut in rectangular strips of uniform width, not less than about 250

mm X 300 mm in size but not so large that it is inconvenient to handle and transport these without damage. During wet weather, the sod shall be allowed to dry sufficiently to prevent rearing during

handlingandduringdryweathershallbewateredbeforeliftingtoensureitsvitalityandpreventthe dropping of the soil in handling.

3.21.3 ConstructionOperationsforTurfingwithSods

Preparationofearthbed

Theareato besodded shallhave been previouslyconstructedto the requiredslopeand crosssection. Soil on the area shall be loosened, freed of all stones larger than 50 mm size, sticks, stumps and any undesirableforeignmatter,andbroughttoareasonablyfinegranulartexturetoadepthof notlessthan25 mm for receiving the sod.

Where required, topsoil shall be spread over the slopes. Prior to placing the topsoil, the slopes shall be scarifiedtoadepthwhich,aftersettlement,willprovidetherequirednominaldepth shownontheplans. Spreading shall not be done when the ground is excessively wet.

Followingsoil preparationandtopsoiling,whererequired,fertilizer andgroundlimestonewhenspecified shallbespreaduniformlyattherateindicatedontheplans.Afterspreading,thematerialsareincorporated in the soil by discing or other means to the depths shown on the plans.

Placingthesods

The prepared sod bed shall be moistened to the loosened depth, if not already sufficiently moist, and the sod shall be placed thereon within approximately 24 hours after the same had been cut. Each sod strip shallbelaidedgetoedgeandsuchthatthejointscausedbyabuttingendsarestaggered.Everystrip,after it is snugly placed against the strips already in position, shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil.

Onsideslopessteeperthan2(horizontal)to1(vertical),thelayingofsodsshallbestarted frombottom upwards.At points wherewatermayflowover a sodded area,the upperedges ofthe sod stripsshall be turnedintothesoil belowtheadjacentareaandalayerofearthplacedover thisfollowedbyitsthrough

compaction.

Stakingthesods

Wherethesideslopeis2(horizontal)to1(vertical)orsteeperandthedistancealongtheslopeismore than 2 m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000 mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods to be almost flush with them.

Topdressing

After the sods have been laid in position, the surfaceshallbe cleaned of loosesod,excess soiland other foreignmaterial.Thereafter,athinlayeroftopsoilshallbescatteredover thesurfaceoftopdressingand the area thoroughly moistened by sprinkling with water.

Wateringandmaintenance

ThesodsshallbewateredbytheContractorforaperiodofatleastfourweeksafterlaying.Wateringshall be so done as to avoid erosion and prevent damage to sodded areas by wheels of water tanks.

TheContractorshallerectnecessarywarningsignsandbarriers,repairorreplacesodded areasfailingto show uniformgrowth of grass or damaged by his operations and shall otherwise maintain the sod at his cost until final acceptance.

MeasurementforPayment

Turfingwithsodsshallbemeasuredasfinishedworkinsquare metres.

Rate

TheContractunitrateforturfingwithsodsshallmeanpaymentinfullforcarryingoutalltherequired operations explained above including compensation for:

FurnishingallthematerialstobeincorporatedintheWorkswithallleadsandlifts;and

Alllabour,tools,equipmentandincidentaltocompletetheworkinaccordancewiththeseSpecifications.

SeedingandMulching

3.22.1
Scope

This shall consist of preparing slopes, placing topsoil, furnishing all seeds, commercial or organic fertilizers and mulching materials, providing jute netting and placing and incorporation the same on embankmentslopesorotherlocationsdesignatedbytheEngineerorshownintheContractdocuments.

3.22.2
Materials

Seeds

Theseedsshallbeapprovedqualityandtypesuitableforthesoilonwhichthesearetobeapplied,and shall have acceptable purity and germination to requirements set down by the Engineer.

Fertilizer

Thisshallconsistofstandardcommercialmaterialsandconformtothegradespecified.Organicmanure shall be fully purified organic matter such as cow dung.

Mulchingmaterials

This shall consist of straw, hay wood shavings or sawdust and shall be delivered dry. They shall be reasonablyfreeofweedseedandsuchforeignmaterialsasmaydetractfromtheireffectivenessasmulch or be injurious to the plant growth.

Topsoil

Topsoil shall not be obtained from an area known to have noxious weeds growing in it. If treated with herbicidesorsterilents,itshallbegottestedbyappropriateagriculturalauthoritytodetermine theresidual in the soil. Topsoil shall be contain less than 2 per cent and more than 12 per cent organic matter.

BituminousEmulsion

Asuitable grade of bituminous cutbackor emulsionused asa tie downfor mulchshall beas describedin theContractdocumentorasdesiredbytheEngineer.Emulsifiedbitumenshallnotcontai

nanysolventor diluting agent toxic to plant life.

Netting

Jutenettingshall beundyedjuteyamwovenintoauniformopenweavewithapproximate2.5cmsquare openings. Geonetting shall be made of uniformly extruded rectangular mesh having mesh opening of 2 cm x 2 cm. The colour may be black or green. It shall weigh not less than 3.8 kg per 1000 sq. m.

3.22.3

SeedingOperations

Seed-bedPreparation

Theareatobeseededshallbebrought totherequiredslopeandcross-sectionbyfilling,reshapingeroded areas and refinishing slopes, median etc. Topsoil shall be evenly spread over the specified areas to the depth shown on the plans, unless otherwise approved by the Engineer. The see-bed preparation shall consist of eliminating all live plants by suitable means using agricultural implements. All stones 150 mm in smallest dimension and larger shall be removed. The soil shall be excavated on the contour to a depth of 100 mm. All clodslarge than 25 mmin diametershall be crushed andpacked.Where necessary, water shall then be applied. All topsoil shall be compacted unless otherwise specified or approved by the Engineer. Compaction shall be by slope compactor, cleated tractor or similar equipment approved by the Engineer.Equipmentshallbesodesignedandconstructedastoproduceauniformrought exturedsurface ready for seeding and mulching and which will bond the topsoil to the underlying material. The entire area shall be covered by a minimum of 4 passes or 2 round trips of the roller or approved equipment.

Fertilizerapplication

Fertilizertotherequiredquantitiesshallbespreadandthoroughlyincorporatedintothes oilsurfaceasa part of the seed-bed preparation.

Plantingof seeds

All seeds shall be planted uniformly at the approved rate. Immediately after sowing, the area shall be raked, dragged or otherwise treated so as to cover the

seeds to a depth of 6 mm. The operation of seed sowingshallnotbeperformedwhenthegroundismuddyorwhenthesoilorweatherconditionswould otherwise prevent proper soil preparation and subsequent operations.

SoilMoistureandWatering requirements

Soilmoistureshallexistthroughoutthezonefrom25mmtoatleast125mmbelowthesurfaceatthe time of planting. Watering off the seeded areas shall be carried out as determined by the Engineer.

Mulching,ApplyingBituminousEmulsionandJuteNetting/ Geonetting

Within24hoursofseeding,mulchingmaterialmixedwithorganicmanureshallbeplaced soastoforma continuous, unbroken cover of approximate uniformthickness of 25 mmusing an acceptable mechanical blower. Mulching material shall be held in place and made resistant to being blown away by suitable means approved by the Engineer. When called for in the Contract documents, mulch material shall be anchored in place with bituminous emulsion applied at the rate of 2300 liters per hectare. Any mulch disturbed or displaced following application shall be removed, reseeded and remulched as specified. Jute netting / Geonetting shall be unrolled and placed parallel to the flow of water immediately following the bringing, to finished grade, the area specified on the plans or the placing of seed and fertilizer. Where more than one strip is required to cover the given areas, they shall overlap a minimum of 100 mm. Jute netting/ Geonettingshall be held inplace byapproved wirestaples, pins,spikes or woodenstakes driven vertically into the soil

Maintenance

The Contractor shall maintain all seeded and mulched areas until final acceptance. Maintenance shall includeprotectionoftrafficbyapprovedwarningsignsorbarricadesandrepairinganyareasdamaged following the seeding and mulching operations. If mulched areas become damaged, the area shall be reshaped and then seeded and mulched again as originally specified.

Measurementfor payment

Seedingandmulchingshallbemeasuredasfinishedworkinsquaremetres.

Rate

TheContractunitrateforseedingandmulchingshallbepaymentinfullforcarryingoutallth

erequired operations including full compensation for all materials, labour, tools and incidentals.

PreparationandSurfaceTreatmentofFormation

Preparation and surface treatment of the formation, that is top of the subgrade, shall be carried out only after completion of any specified subgrade drainage and unless otherwise agreed by the Engineer, immediatelypriortolayingthesub-baseortheroadbasewherenosub-baseisrequired.Thesequenceof operations shall be as follows:

Allsurfacesbelowcarriageway,laybyes,footwaysandhardshouldersshall,afterreinstatementofany soft areas to the required Specifications be well cleaned and freed of mud and slurry.

Thesurfaceshallbecompactedby4passesofasmoothwheeledrollerof80to100kNweightafter spraying requisite amount of water, if required, before the commencement of rolling.

Theformationshall,wherevernecessary,beregulatedandtrimmedtotherequirements withmotor grader.

Thetrimmedformationshallberolledbyonepassofsmoothwheeledrollerof 80to100kNweightafter spraying requisite amount of water, if required, before the commencement of rolling.

Where the completed formation is not immediatelycovered with sub base or road base material,its moisture content shall be maintained to prevent cracking in the formation by suitable measures as approved by the Engineer. The entire work of surface treatment of formation shall be deemed as incidentaltotheworkofsub-base/basecoursetobeprovidedonthesubgradeandassuchnoextra payment shall be made for the same.

WorkstobeKeptFreeofWater

The Contractor shall arrange for the rapid dispersal of water collected / accumulated on the earthwork or completedformationduringconstructionorontheexistingroadwayorwhichentersthe

earthworkorany other item of work from any source, and where practicable, the water shall be discharged into the permanent outfall of the drainage system. The arrangement shall be made in respect of all earthwork including excavation for pipe trenches, foundations or cuttings.

The Contractor shall provide, where necessary, temporary water courses, ditches, drains, pumping or othermeansformaintainingtheearthworkfreefromwater.Suchprovisionsshallinclude carryingoutthe work of forming the cut sections and embankments in such manner that their surfaces have at all times a sufficient minimum crossfall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

Theworksinvolvedinkeepingtheearthworkoranyotheritemofworksfreeofwatershallbed eemedas incidental to the respective item of work and as such no separate payment shall be made for the same.

Gabion Embankment

Gabions are compartmented rectangular containers made of heavily galvanised steel wire, filled with stones, the gabion becomes a large, flexible and permeable building block. Gabions comprises of welded wiremeshpanelsaccuratelycuttosizewithheavysectionwirespiralsusedforinterconnec tingtheedges. The meshes and spirals are pre galvanized with zinc coating of 450 gram per m2. Gabion shall be confirming to ASTM-A974 (Standard Specifications for Welded Wire Fabric Gabions and Gabion Mattresses).

Welded wire mesh is a prefabricated reinforcement consisting of a series of parallel longitudinal wires with accurate spacingwelded tocross wires at the required spacing.The weldingof the wires is achieved by electric resistance welding with solid state electronic control and all the spacing are controlled by the automatic mechanism of high reliability. There is no foreign metal added at the joint. The intersecting wires are actually fused into a homogeneous section thereby ensuring permanency of spacing and alignment in either direction. Welded Mesh shall be as per IS:4948 (latest Version). Gabions shall be fabricatedinsuchamannerthat thesides,ends,lidsanddiaphragmscanbeassembledattheconstruction site intoa rectangularbasket ofthespecified sizes.Thebasket shall bea single unit construction. In other words, the base, lid and sides shall be woven into a single unit. The ends and diaphragms shall be connectedtothebasesectionofthegabion.Thisconnectionshouldbesuchthatstrengthan dflexibilityat the point of intersection is at least equal to that of the mesh.Gabion shall be provided minimum 0.5m below ground level.

The boulders shall be hard and shall not deteriorate under water. The section shall be worked out

considering10%porositywithadepthof1mbelowthegroundtoatoplevel.Theslopecanb eupto 1:0.25. boulder size shall not exceed 200mm.

3.24 SiteFilling

Sand fill

Sandyfillshallbedepositedtobringthegradeleveltothedesiredelevationaftercompacti onoffill. Sandy fill shall be carried out in one of the following methods as detailed in the drawings:

Compaction of sandy fill by flooding the area shall be carried out where so specified.In this case, Contractorshouldensurethatthefillmaterialisnotwashedaway.Thisworkshallbecarrie doutas directed by Engineer.

Sandyfillshallbecompactedwheresospecifiedby12tonnevibratingrollers.Thefillmateria lshallbe compacted to the required density.

If the densityof fill or use of rollers for compactionis not specified, Contractor shall ensure necessary compactionbythepassageoftrucks,carryingthefillmaterialoverthedepositedfillinsuc hawaythat the entire fill area is covered.This will reasonably compact the sand fill and will be accepted by Engineer.However, Contractor shall ensure that every layer is thus compacted before the succeeding layers are deposited.Each layer shall not exceed 200mm in thickness.

Soilfill

Approved soil fill consisting of ordinary soil, murrum, soil containing gravel, shingle, etc. shall be depositedinlayersnotexceeding200mm.Contractorshouldensurethatallclodsofearth arebroken down to a size not larger than 100mm.

Wheredensityoffilloruseofrollersisnotspecified,thefillshallbecarriedoutasspecifieda

bove. Where specified, the required density to fill shall be obtained by proper

compaction.

Measurement

MeasurementshallbemadeonthebasisofClause3.13.

EndofSection-3

SECTION – 4
CONCRETEANDALLIEDWORKS

SECTION-4

CONCRETEANDALLIEDWORKS

Applicable Codes

Materials

1) IS:269 SpecificationforOrdinaryPortlandcement.
2) IS:455 SpecificationforPortlandslagcement.
3) IS:1489 SpecificationforPortland-pozzolanacement(Part 1&2).
4) IS:12330 SpecificationforsulphateresistingPortlandcement.
5) IS: 383 Specificationforcoarseandfineaggregatesfromnatural sourcesfor concrete.
6) IS: 432 Specificationformildsteelandmedium(tensilesteelbars and hard- drawnsteel)wiresforconcretereinforcement. (Part1and 2)
7) IS: 1786 Specificationforhighstrengthdeformedsteelbarsand wires for concrete reinforcement.
8) IS:1566 Specificationforhard-drawnsteelwirefabricforconcrete reinforcement.
9) IS:9103 Specificationforadmixturesfor concrete.
10) IS:2645 Specificationforintegralcementwater-proofingcompounds.
11) IS:4990 Specificationforplywoodforconcreteshuttering work.

MaterialTesting

1) IS:650 Specificationforstandardsandfortestingof cement
2) IS:2430 Methodsforsamplingofaggregatesfor concrete.
3) IS.2386 Methodsoftestforaggregates forconcrete(Parts1to 8)
4) IS: 3025 Methodsofsamplingandtest(physicalandchemical)forwaterusedin industry.
5) IS.4031 Methodsofphysicaltestsforhydraliccement(Parts1to15)
6) IS:4032 Methodchemicalanalysisofhydraulic cement.
7) IS: 6925 Methodsoftestfordeterminationofwatersolublechloridesinconcrete admixtures.

Material Storage

1) IS: 4082 Recommendationsonstackingandstoringofconstructionmateri

alsat site.

ConcreteMixDesign

1)IS:10262 Recommendedguidelinesforconcretemixdesign.
2)SP:23(S&T)HandbookonConcrete Mixes.

ConcreteTesting

1) IS:1199 Methodofsamplingandanalysisofconcrete.
2) IS:516 Methodof test forstrength of concrete.
3) IS: 9013

Methodofmaking,curinganddeterminingcompressive strengthof accelerated cured concrete test specimens.
4) IS: 8142

Methodoftestfordeterminingsettingtimeofconcretebyp enetration resistance.
5) IS:9284 Methodof testforabrasionresistanceof concrete.
6) IS:2770 Methodsoftestingbondinreinforcedconcrete.

Equipments

1) IS:1791 Specificationforbatchtypeconcretemixers.
2) IS:2438 Specificationforrollerpanmixer.
3) IS:4925 Specificationfor concretebatchingandmixingplant.
4) IS:5892 Specificationforconcretetransitmixerandagitator.
5) IS:7242 Specificationforconcretespreaders.
6) IS:2505 GeneralRequirementsforconcretevibrators: Immersiontype.
7) IS:2506 GeneralRequirementsforscreedboardconcrete vibrators.
8) IS:2514 Specificationforconcretevibratingtables.
9) IS:3366 Specificationforpanvibrators.
10) IS:4656 Specificationforformvibratorsforconcrete.
11) IS:11993 Codeofpracticeforuse ofscreedboard concrete vibrators.
12) IS:7251 Specificationforconcrete finishers.
13) IS: 2722

Specificationforportableswingweighbatchersforconcrete (singleand double bucket type).
14) IS:2750 S Specificationforsteelscaffoldings.

Codesof Practice

1) IS:456 Codeofpracticeforplainandreinforcedconcrete.
2) IS: 457

Codeofpracticeforgeneralconstructionofplainandreinforce dconcrete for dams and other massive structures.
3) IS: 3370

Codeofpracticeforconcretestructuresforstorageofliqui ds (Parts 1 to 4)
4) IS:3935 Codeof practicefor composite construction.
5) IS:2204

Codeofpracticeforconstructionofreinforcedconcreteshellroof.

6) IS: 2210

Criteriaforthedesignofreinforcedconcreteshellstructures and folded plates.

7) IS: 2502

Codeofpracticeforbendingandfixingofbarsforconcrete reinforcement.

8) IS: 5525

Recommendationfordetailingofreinforcementinreinforced concrete works.

9) IS: 2911

CodeofpracticeforDesignandconstructionofPilefoundations. (Part 1 to 4)

10) IS:9417 Specificationforweldingcoldworkedbarsfor reinforcedconcrete construction.
11) IS: 3558 Codeofpracticeforuseofimmersionvibratorsforconso lidating concrete.
12) IS:3414 Code ofpracticefordesignand installationof jointsin buildings.
13) IS: 4326 Codeofpracticeforearthquakeresistantdesignandcons tructionof building.
14) IS:4014 Codeof practiceforsteeltubular scaffolding(Parts 1 &2)
15) IS:2571 Codeofpracticeforlayinginsitucementconcrete flooring.
16) IS:7861 Codeofpracticeforextremeweatherconcreting:Pa rt1Recommended practice for hot weather concreting.
17) IRC:112 CodeofpracticeforConcreteRoadBridges.
18) IRC:78 StandardSpecificationsandCodeofPractice forRoadBridges.
18) IRC:21 StandardSpecificationsandCodeofPractice forRoadBridges.
19) IS:919 Recommendationforlimitsandfitsforengineering.
20) IS:1597 ConstructionofStoneMasonry(PartI&II)

ConstructionSafety

1) IS:3696 Safetycode forscaffoldsand ladders.(Parts1&2)
2) IS:7969 Safetycode forhandlingandstorageof building materials.
3) IS:8989 Safetycode forerection ofconcreteframedstructures.

Measurement

1) IS:1200 MethodofmeasurementofbuildingandEngineering works
2) IS:3385 CodeofpracticeformeasurementofCivilEngineeringworks

General

The Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the Engineer’sapprovalobtained,priortostartingofconcretework.Thisshall,howev er,notrelieve the Contractor of any of his responsibilities. All materials which do not conform to the Specifications shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and theenvironmentalconditionstowhichthestructurewillbesubjected.Materialsc

omplyingwith codes/standards shall generally be used. Other materials may be used after approval of the Engineer and after establishingtheir performance suitabilitybased on previous data, experience or tests.

Materials

Cement

Unless otherwise called for by the Engineer, cement shall be ordinary Portland cement conformingtoIS:269.WherePortlandpozzolanaorslagcementsareused,itshall beensured that consistency of quality is maintained, there will be no adverse interactions between the materials and the finish specified is not marred.
Only one type of cement shall be used in any one mix. The source of supply, type or brand of cementwithinthesamestructureorportionthereofshallnotbechangedwithouta pprovalfrom the Engineer. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage bins and storage arrangement shall be approved by theEngineer.Consignmentsofcementshallbestoredasreceivedandshall beconsumedinthe order of their delivery. Storage of cement shall be as per standard practices.

Cement which is not used within 90 days from its date of manufacture shall be tested at a laboratoryapprovedbytheEngineeranduntiltheresultsofsuchtestsarefoundsat isfactory,it shall not be used in any work.

Aggregates(General)

Aggregatesshallconsistofnaturallyoccurringstones(crushedoruncrushed),gr avelandsand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/ organic impurities/deleterious materials and conform to IS: 383.

Aggregatessuchasslag,crushedoverburntbricks,bloatedclayash,sinteredflyas handtiles shall not be used.

Aggregatesshallbewashedandscreenedbeforeusewherenecessaryorifdirecte dbythe Engineer.Aggregate source shall be approved by BWSSB.

Aggregates containing reactive materials shall be used only after tests conclusively prove that therewillbenoadverseeffectonstrength,durabilityandfinish,includinglongter meffects,on the concrete.

Thefineness modulusofsandshall neitherbelessthan2.2 normorethan 3.2.

Themaximumsizeofcoarseaggregateshallbeasstatedonthedrawingsbutinnoc asegreater than 1/4 of the minimum thickness of the member.

Plums160mmandaboveofareasonablesizemaybeusedinmassconcretefillwhere

directed. Plums shall not constitute more than 20% by volume of the concrete.
The natural/ river sand to be used shall be clean, sieved and of good quality. As far as possible natural/ river sand shall be used. Whenever there is scarcity of natural/ river sand, manufactured sand/crushedsand canbeusedtoamaximumextentof50%oftotalsand quantityforplastering

itemsand100%forconcreteitems.ThecertificationbytheconcernedexecutiveEngineer, Quality Control is mandatory for usage of artificial/ manufactured sand.

Allcoarseandfineaggregatesshallbestackedseparatelyinstockpilesinthematerialyardnearthework siteinbinsproperlyconstructedtoavoidintermixingofdifferentaggregates.Contaminationwithforeign materialandearthduringstorageandwhileheapingthematerialsshallbeavoided.Theaggregatesmustbe ofspecifiedqualitynotonlyatthetimeofreceivingatsitebutmoresoatthetimeofloadingintomixer. Rakersshallbepiledinlayersnotexceeding1.20minheighttopreventconingorsegregation.Eachlayer shallcovertheentireareaofstockpilebeforesucceedinglayersarestarted.Aggregatesthathavebecome segregated shall be rejected.

ForeignMaterialLimitationsinFineAggregate

S. No.	**ForeignMaterial**	**Percentagebyweight**	
		Uncrushed	**Crushed**
1	Materialfinerthan75 micronBIS	3.0	15.0
2	Shale	1.0	-
3	Coal& Lignite	1.0	1.0
4	Claylumps	-	1.0
Total		**5.0**	**17.0**

GradingofSandforFineAggregate

BIS:Sieve Designation	**GradingZone I**	**GradingZoneII**	**Grading ZoneIII**	**Grading ZoneIV**
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-90	90-100
600µm	15-34	35-59	60-79	80-100

GradingofSandforCoarseAggregate

BIS: Sieve Size	**Percentagepassingforsinglesizedaggregateof normal size**					**Percentagepassingfor graded aggregate of normal size**			
	40 mm	**20 mm**	**16 mm**	**12.5 mm**	**10 mm**	**40 mm**	**20 mm**	**16 mm**	**12.5 mm**

63 mm	100	-	-	-	-	-	-	-	-
40 mm	85-100	100	-	-	-	95-100	100	-	-
20 mm	0-20	85-100	100	-	-	30-70	95-100	100	100
16 mm	-	-	85-100	100	-	-	-	90-100	-
12.5 mm	-	-	-	85-100	100	-	-	-	90-100
10 mm	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75 mm	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36 mm	-	-	-	-	0-5	-	-	-	-

ForeignMaterialLimitationsinCoarseAggregate

S. No.	**ForeignMaterial**	**Percentagebyweight**	
		Uncrushed	**Crushed**
1	Materialfinerthan75micronBIS Sieve	3.0	3.0
2	CoalandLignite	1.0	1.0
3	ClayLumps	1.0	1.0
4	SoftFragments	3.0	-
Total		**8.0**	**5.0**

Water

Waterusedforbothmixingandcuringshallconformto IS:456.Potablewatersaregenerally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.
Contractorshallalsousetreatedwaterbeingsold byBWSSB,toendexploitationof ground water.

Reinforcement

In general, reinforcement shall conform to HYSD-CRS-500 and otherreinforcement bars shall conformtoIS:432orIS:1786andweldedwirefabrictoIS:1566asshownorspecifiedonthe drawing.

Allreinforcementshallbeclean,freefrompitting,oil,grease,paint,loosemillscales, rust,dirty, dust, or any other substance that will destroy or reduce bond.

Admixtures

Accelerating,retarding,water-reducingandairentrainingadmixturesshallconformtoIS:9103 and integral water proofing admixtures to IS: 2645.

Admixtures maybeused in concrete as per manufacturer's instructions onlywith theapproval of the Engineer. An admixture's suitability and effectiveness shall be verified by trial mixes with theothermaterialsusedintheworks.Iftwoormoreadmixturesaretobeusedsimultaneouslyin the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. Thereshould also beno increasein risk ofcorrosion of thereinforcement orother embedment.

Calciumchlorideshallnotbeusedforacceleratingsetofthecementforanyconcrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not

exceeding1.5percentoftheweightofthecementineachbatchofconcrete.Thedesigned concrete mix shall be corrected accordingly.

AirEntrainingAgents

Neutralized Vinson resin or other approved air in the concrete mix agents shall conform to the requirementsofASTMstandard6.260;AirEntrainingAdmixturesforConcrete.Therecommendedtotal air content of the concrete is 4% + 1%. The method of measuring air content shall be as per IS: 1199.

WaterReducingAdmixtures

WaterreducinglignosulfonateadmixturemaybeaddedinquantitiesapprovedbytheEngineer.The admixtures shall be added in the form of a solution.

RetardingAdmixtures

Retardingagentsmaybeaddedtotheconcretemixinquantitiesapprovedbytheengineer.

WaterProofingAgent

WaterproofingagentsshallconformtoIS:2645.

OtherAdmixtures

TheEngineermayathisdiscretionallowthecontractortouseanyotheradmixturein theconcrete.

Wastage

Wastageallowanceforcementandsteelandhigherrollingmarginforsteelshallbeconsidered in the item rate and no extra payment shall become payable to the Contractor on any account.

SamplesandTests

Allmaterialsusedfortheworksshallbetestedbeforeuse.Manufacturer'stestcertificateshallbe furnishedforeachbatchofcement/steelandwhendirectedbytheEngineersamplesshallalsobe got tested by the Contractor in a laboratory approved by the Engineer at no extra cost to Employer. Sampling and testing shall be as per IS: 2386 under the supervision of the Engineer.
Waterto beused shallbetestedto complywith requirementsofIS: 456.

The Contractor shall furnish manufacturer's test certificates and technical literature for the admixtureproposedtobeused.Ifdirected,theadmixtureshallbegottestedatanapproved laboratory at no extra cost.

Storingof Materials

All materials shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works.
Requirements of IS: 4082 shall be complied with. The Contractor will have

to make his own arrangements for the storage of adequate quantity of cement.Ifsuchcementisnotstoredproperlyandhasdeteriorated,thematerialsh all berejected. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags

shall be stacked in any tier. Storage arrangement shall be approved by the Engineer. Storage undertarpaulinsshallnotbepermitted.Eachconsignmentofcementshallbestored separately and consumed in its order of receipt.

Each size of coarse and fine aggregates shall be stacked separately and shall be protected from leavesandcontaminationwithforeignmaterial.Thestacksshallbeonhard,clean,freedraining bases, draining away from the concrete mixing area.

TheContractorshallmakehisownarrangementsforstoringwateratsiteintankstoprevent contamination.

Thereinforcementshallbestackedontopoftimbersleeperstoavoidcontactwithground/water. Each type and size shall be stacked separately.

Concrete

General

Concretegradeshallbeasdesignatedondrawings.InconcretegradeM15,M20 etc.thenumber represents the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/sq.mm as per IS:456. Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M10 and M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX CONCRETE.
Thegradesofconcretetobeusedarenotedonthedrawings.Inaddition,thefollowingtable shall apply unless specified otherwise.

Structure	**Grade of Concrete**	**Max.Aggregate Size**
1. All Liquidretainingstructures/Wetwells/ Bridges/Piles/Pilecaps	M30	20 mm
2. SewagePumpingStations/ Buildings (a) forfoundationraft (b) forwalls,columns,floorbeams,circularfloor slab (c)forbeams,slabsetc.	 M25 M25 M25	 20 mm 20 mm 20 mm
3. Valve chambers (a) forfoundationraft (b) walls, columns (c)forslabs,beams,etc.	 M25 M25 M25	 20 mm 20 mm 20 mm
4.Anchorblocks/Thrustblocks/ Antiflotation	M20	40 mm

blocks		
5.Saddles	M25	20mm
6.Pipelineembankment,gradeslab,ramps, footings under walls, SW drain coping etc	M15	20 mm
7.Bridges Foundation of piers and abutments Piersandabutmentswithwingwalls Hammer head of pipes	M30 M30 M30	20 mm 20 mm 20 mm
8.Causeway	M20	20 mm
9.Manholes	M30	20 mm

ControlledConcrete

All concrete in the works shall be “Controlled Concrete” as defined in IS: 456 except for M-10 for which normal mix concrete shall be used. Whether reinforced or otherwise, all concrete works to be carried out under this specification shall be divided into the following classifications:

Note:Itshallbeveryclearlyunderstoodthatwheneverthegradeofconcretesuchas M-20,etc.isspecified itshallbecontractor’sresponsibilitytoensuretheminimumcrushingstrengthstipulated fortherespective grade of concrete is obtained at works.

Class	**Preliminary TestN/mm²**		**WorksTest N/mm²**		**Maximum size of aggregate mm**	**Locationsfor use**
	At7 Days	**At28 Days**	**At7 Days**	**At28 Days**		
M30	25.0	38.0	20.0	30.0	40or20	Asindicatedinthe specificationsorasrequired
M25	22.0	32.0	17.0	25.0	40or20	-do-
M15	13.5	20.0	10.0	15.0	40or20	-do-

For Design Mix Concrete, the mix shall be designed according to IS: 10262 and SP: 23 to provide the grade of concrete havingthe required workabilityand characteristic strength not less than appropriate values given in IS: 456. The design mix shall in addition be such that it is cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result

inwatertightconcrete.TheContractorshallexercisegreatcarewhiledesigningth econcretemix and executing the works to achieve the desired result based on SP23 Fig 37 of minimum cement paste volume in concrete for durability.

TheminimumcementcontentforDesignMixConcreteshallbeasperTable-5ofIS:456andfor Pile foundations as per IS: 2911 or as given below, whichever is higher.

Grade of Concrete	MinimumCementContention Kg/Cu.m of Concrete
M20 M25 M30	320 360 400

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement.The Contractor’s quoted ratesforconcreteshallprovidefortheaboveeventualityandnothingextrashallbecomepayable to the Contractor in this account.Even in the case where the quantity of cement required is higher than thatspecified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the Contractor.

The Contractor shall submit details of the source of all material and the proposed quantities of each ingredient per cubic metre of fully compacted concrete.The Contractor shall then make trial mixes for each class of concrete using the same Contractor’s Equipment and the same materialsasareproposedforthePermanentWorks.TheContractorshallgive24hoursnoticeof such trials to enable the Engineer’s Representative to attend.For each trial mix, three separate batches of concrete shall be made by the Contractor and will be tested at 28 days all in accordance with IS: 516.Such trial mixes shall not be the first batch through the plant in any one sequence of concrete production.

TheContractor shall not commence concretingin the Permanent Works until details of trial mixesandtestresultsforeachclassofconcretehavebeensubmittedtoandapprovedbythe Engineer.

Unlessotherwisespecified,onlymediumgradedfineaggregateshallbeused Atrialmixdesignwillbeapprovedbytheengineerwithrespecttostrengthiftheaverage compressive strength of the nine cubes so tested is more than the target means strength appropriate to the grade of concrete.

For concrete of Grade 30 and over the Contractor shall cast two sample wall panels 48 hours apart.Each shall be cast in two equal lifts to form a wall panel having one horizontal construction joint formed in the manner proposed by the Contractor for the Works.The top surface of the second lift shall have a Type U3 finish.The panels shall not be touched up after stripping.Thepanelsshallbe300mmthickand1.5mlongby1.5mhigh.TheContractorshall not commence concreting in the Permanent Works until the test panels have been approved by Engineer.

TheContractorshallnotaltertheapprovedmixproportionsortheapprovedsourceofsupplyof any of the ingredients without having previously obtained the

approval of the Engineer.
Duringproduction,theEngineermayrequiretrialmixestobemadebeforeasubst
antialchange is made in the materials or in the proportions of the materials
to be used.

It shall be the Contractor's sole responsibilityto carry out the mix designs at his own cost. He shall furnish to the Engineer at least 30 days before concreting operations, a statement of proportionsproposedtobeusedforthevariousconcretemixesandthestrengthresultsobtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of IS:456 as follows:

A

Grade of Concrete	Minimum Compressive Strength N/sq.mmat 7days	SpecifiedCharacteristic Compressive Strength N/sq.mmat 28days
M 15	10.0	15.0
M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0

rangeofslumpswhichshallgenerallybeusedforvarioustypesofconstructionunlesotherwise instructed by the Engineer is given below:

Workability

The workability of concrete shall be checked at frequent intervals by slump test. Where facilities exist andifrequiredbytheEngineer,alternativelythecompactingfactortestinaccordancewithIS:1199 shall be carried out. The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of form work and round the reinforcement to give the required surface finish shall depend on the type and nature of the structure and shall be based on experience and tests

Workmanship

Allworkmanshipshallbeaccordingtothelatestrelevantstandards.Beforestartingapourthecontractor shall obtain the approval of the Engineer in a “Pour Card” maintained for this purpose. He shall obtain complete instructions about the material and proportion to be used, slump, workability of water per unit of cement, number of test cubes to be taken, finishing to be done and any admixture to be added etc

Structure/Member	Slumpin millimeters	
	Maximum	Minimum
Reinforcedfoundationwallsandfoo	75	40
tings Plain footings, caissons	75	40
and substructure walls	100	50
Slabs,Beamsandreinforcedwalls	75	40
&miscellaneousEquipmentFound	100	40
ation ng columns	50	40
ents	50	40
mass construction		

Note:Allconcretingdoneforwaterretainingstructuresshallhaveaminimumslump valueof80 mm and maximum of 100 mm

Batching&Mixingof Concrete

It is expected that batching plants of minimum 30 m^3 capacity, with two silos and pumps for placingconcreteshallbeused.Proportionsofaggregatesandcement,asdecidedb ytheconcrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by the Engineer shall be maintained.Eachtimetheworkstops,themixershallbecleanedout,andwhilerec ommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

Arrangement should be made by the Contractor to have the cubes tested in an approved laboratoryorinfieldwithpriorconsentoftheEngineer.Samplingandtestingofstr engthand workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456.

NominalMixConcrete

MixDesign&Testing

Mix design and preliminary tests are not necessary for Nominal Mix Concrete. However works testsshallbecarriedoutasperIS:456.ProportionsforNominalMixConcreteandw/ cratiomay be adopted as per Table 9 of IS: 456. However it will be the Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

Batching&Mixingof Concrete

Basedontheadoptednominalmixes,aggregatesshallbemeasuredbyvolume.How evercement shall be by weight only, using whole bags of cement.

Formwork

Formworkshallbeallinclusivenotbelimitedtoshores,bracings,sidesoffootings, walls,beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, falsework, wedgesetc. Thedesignandengineeringoftheformworkaswellasitsconstructionshallbether esponsibility of the Contractor. However, if so desired by the Engineer, the drawings and calculations for the design of the formwork shall be submitted to the Engineer for approval.

Formworkshallbedesignedtofulfill thefollowingrequirements:

1. Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages andappropriate to the methods of placing and compacting.

2. Madeofsuitable materials.

3. Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

4. Capable of withstanding without deflection the worst combination of selfweight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.

5. Capableofeasilystrikingwithoutshock,disturbanceordamagetotheconcrete.

6. Soffitformscapableofimpartingacamberifrequired.

7. Soffitformsandsupportscapableofbeingleftinpositionif required.

8. Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete. design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

Theformworkmaybeoftimber,plywood,steel,plasticorconcretedependingupont hetypeof finish specified. Sliding forms and slip form may be used with the approval of the Engineer.
Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes,
warpsandothersurfacedefects.Jointsbetweenformworkandformworkandbetw eenformwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.
The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement.
All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before
theconcreteisplaced.Wheredirected,cleaningofformsshallbedonebyblasting withajetof compressed air at no extra cost.
Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used.Before reuse,
allformsshallbethoroughlyscraped, cleaned,nailsremoved,holessuitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Engineer. The
Contractorshallequiphimselfwithenoughshutteringtoallowforwastagesoasto completethe job in time.
Permanentformworkshallbecheckedforitsdurabilityandcompatibilitywithadj oining concrete before it is used in the structure. It shall be properly anchored to the concrete.
Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts
passingthroughsleevesshallbeused.Formworkspacersleftinsitushallnotimpai rthedesired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.
Forliquidretainingstructures,sleevesshallnotbeprovidedforthroughboltsnors hallthrough boltsberemovedifprovided.Thebolts,inthelattercase,shallbecut at25mmdepthfromthe surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.
Allcornersandanglesexposedinthefinishedstructureshallhavechamfersorfillets

of20mmx 20 mm size, except where specified in the drawings. Formsforsubstructuremaybeomittedwhen,intheopinionoftheEngineer,theopenexcavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be larger, as

approvedbytheEngineer,thanthatrequiredasperdrawingtocompensateforirregularitiesin excavation.
TheContractorshallprovideadequatepropscarrieddowntoafirmbearingwithout overloading any of the structures.
The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceedsorwindowsleftforplacingconcretefromthesidetolimitthedropofconcreteto1.0m or as approved by the Engineer. The Contractor shall temporarily and securely fix items to be cast (embedment's/ inserts) in a manner that will not hinder the striking of forms or permit loss of grout.
Formworkshowingexcessivedistortion,duringanystageofconstruction,shallberepositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.
Thestrikingtime for formworkshallbedeterminedbased onthe followingrequirements:

Development of adequate concrete strength;
Permissibledeflectionattimeofstrikingformwork;
Curingprocedureemployed-itsefficiencyandeffectiveness; Subsequent surface treatment to be done;
Preventionofthermalcrackingatre-entrantangles; Ambient temperatures; and
Aggressivenessoftheenvironment(unlessimmediateadequatestepsaretakentoprevent damagetothe concrete).

Under normal circumstances (generally where temperatures are above 20ºC) forms may be struck after expiry of the time period given in IS: 456 unless approved otherwise by the Engineer. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approvedbytheEngineer.ItistheContractor'sresponsibilitytoensurethatforms arenotstruck untiltheconcretehasdevelopedsufficientstrengthtosupportitself,doesnotundergo excessive deformation and resist surface damage and any stresses arising during the construction period.

RemovalofFormwork

Formwork shall be so designed as to permit any removal without resorting to hammering or levering against the surface of the concrete. The periods of time elapsing between the placing of the concrete and the striking of the loads likely to be imposed on the concrete and shall in any case be not less than the periods, shown in Table below. Where soffit formwork is constructed in a manner during and after such removal of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may,withtheagreementoftheEngineer,removetheformworkattheearliertimeslistedbelowprovided that the props are left in position.

Table12

PositionofFormwork	**DaysforStriking**
Walls	1
Sidesofbeamsandcolumns	1
Slabs(Dropsleft under)	3
Propstoslabs(spannotexceeding4.5m)	7
Propstoslabs(spanexceeding4.5m)	14
Beamssoffits(propsleft under)	21

Notwithstandingtheforegoing,theContractorshallbeheldresponsibleforanydamagea risingfrom removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

Striking shall be done slowly with utmost care to avoid damage to projections and without shock or vibration,bygentlyeasingthewedges.Ifafterremovingtheformwork it isfoundthat timber hasbeen embedded in the concrete. It shall be removed and made good as specified earlier.

ReinforcedtemporaryopeningsshallbeprovidedasdirectedbytheEngineer,tofacilitater emovalof formwork which otherwise may be inaccessible.

Therods, clamps, formbolts, etc. which must beentirelyremoved fromwalls orsimilar structuresshall beloosenednotsoonerthan24hoursnotlaterthan40hoursaftertheconcretehasbeende posited.Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and grade beams shall be pulled toward the inside face. Cutting ties back from the faces of the walls and grade beams will not be permitted.

TechnicalSpecificationsforSheetPiling

General

Sheet piling is a form of driven piling using interlocking sheets of steel to obtain a continuous barrier in the ground. The main application of sheet pile is in retaining walls erected for the purpose of excavationto enable permanent works to proceed. Normally vibrating hammer/ impact hammer, crane and crawler drilling are to be used to establish sheet piles. The work shall be done as per BOQ provisions. The work shall include supply, installation and subsequent removal of all miscellaneous steel shapes, plates and connecting hardware when required to attach the sheeting to an existing substructure unit and/or facilitate stage construction.

Allinitialbankinghastobeformedatcontractor'sowncostfortakingthemachinerytodriv ethesheet piles. The area shall be filled driving of steel sheet piles with pit sand for leveling the ground.

Piles shall be driven, true to plumb and alignment. Hammer for sheet pile driving shall be drop hammer, steam hammer, air hammer, diesel hammer or vibratory hammer. Sheet pile driving shall commence initially with minimum impact of hammer, which can be increased later after ensuring that the piles are being driven vertically through the interlocking grooves along with designed alignment. The sheet piles aretobedrivenwithbattenweldedatsuitableintervals.TheSteelSheetPilemaybelifteda tsinglepoint

ApplicableCode

All work shall be carried out strictly in accordance with the Technical Specifications, unless otherwise approvedbyEngineerinwriting.TheIndianStandardCodesapplicabletothissectionsha llincludebut not limited to the following.

INDIANSTANDARDS(ISCODES)

IS 2314:1986

Specificationforsteelsheetpilingsections(firstrevision)

AMERICAN SOCIETY FOR TESTING AND MATERIALS

(ASTM)

ASTMA6/

A6M(2000)GeneralRequirementsforRolledStructuralSteelBars,

Plates, Shapes, and Sheet Piling

ASTMA328/A328M(200)SteelSheetPiling

ASTMA572/A572M(200)High-StrengthLow-AlloyColumbium-

Vanadium Structural Steel

ASTMA690/A690M(1994)High-StrengthLow-AlloySteelH-

Pilesand Sheet Piling for Use in Marine Environments

ASTMA857/A857M(1997el)SteelSheet Piling,ColdFormed,LightGage.

Transportation

The Contractor shall set up, in accordance with the construction schedule make all the necessary arrangements for hauling of all materials for the steel sheet pile driving so that all the materials will be available for immediate use whenever required:

d) Allthesteelsheetpilesshallbedeliveredintactatthesitewithoutcausinganypermanent distortion in the member or injury or deformation at joints.

e) Care shall be taken in handling such materials as tie-rods to avoid damage to the thread and shop coat painting.

f) Handling of such long membersaswalling shallbe carriedout in the sameway asfor the steel sheet piles.

Storage

f) Storage space for steel sheet piles shall be reasonably leveled andcompacted. The site so selected should be got approved by the ENGINEER.

g) Steelsheetpilesshallbestackedinsuchawayastoavoidstrainordistortioninthe materials.

h) Steel sheet piles shall be stacked up in such tiers as each consisting of not more than 3 piles, and between eachtier wooden sleepers shall be inserted at intervals not exceeding4m. Total height of stack shall not exceed 2m.

i) Tie-rods and accessories shall be sorted, stacked in accordance with their diameters and shall be stored under cover and not be directly exposed to weather.

j) TheContractorshallberesponsible for safe handling, mobilization & demobilization and storage of piles and other materials. The rate for sheet pile driving shall include the cost for handlingandstorageof piles andother accessories,formingdrivingpit,formationandremoval of earthen bund if required, all other requisites for successful driving of sheet pile.

Cuttingof Sheet Pile

e) Cuttingofsteelsheetpilesshallbedonebymeansofagascuttingdevice.

f) Steel sheet piles to be cut shall be free from curve and warp, and securely clamped on a levelwork table for cutting.

g) Useofaspecialjigisdesirabletominimizedeformationdueto cutting

h) Whatever method is used in cutting, a certain degree of deformation is bound to occur. If the deformation is less than 40mm, it can be set right by hammering or by heat treatment to the deformed segment. If the deformation exceeds the above range, mechanical correction by means of jacks and press shall be made.

SheetPileWelding

e) Arcweldingshallbeadoptedforsteelsheetpilework.

f) OnlyskilledweldersapprovedbytheENGINEERshallbeengagedforthework.

g) WeldingequipmentshallbeACrectifiers/arc-weldingunit.Weldingrodsshallbethoseconforming to the relevant IS or equivalent and subject to prior approval of ENGINEER.

h) If any welding is rejected by the ENGINEER, the Contractor shall perform the welding again by cutting off at the weld at his cost. All the costs thereof shall be borne by the Contractor.

Materials

Metal sheet piling material shall be conforming to IS:2314 or equivalent ASTM standards. The interlocks of sheet piling shall be free-sliding, provide a swing angle suitable for the intended installation but notless than 5 degrees when interlocked, and maintain continuous interlocking when installed. Sheet piling [including special abricated sections] shall be [full-length] sections of the dimensions as shown in the drawing. Sheet piling shall be provided with standard pulling holes.

Metal plates, shapes, bolts, nuts, rivets, and other appurtenant fabrication and installation materials shall conform to manufacturer's standards and to the requirements specified in the respective sheet piling.

ExtractionofRejectedSheetPile:

If the pile driving work has not been done to the specification, the Contractor shall extract the rejected pile. The extraction shall be such as to avoid damages to the adjoining piles, other structures and installations. Cost of extraction and replacement shall be borne by the Contractor.

Construction

The Contractor shall verify locations of all underground utilities before driving any sheet piling. Any disturbance or damage to existing structures, utilities or other property, caused by the Contractor’s operation, shall be repaired by the Contractor in a manner satisfactory to the Engineer at no additionalcost to the Department. The Contractor shall be responsible for determining the appropriate equipment necessary to drive the sheeting to the tip elevation(s) specified on the plans or according to the Contractor’s approved design. The Contractor shall be responsible for determining the appropriate equipment necessary to drive the sheeting to the tip elevation(s) specified on theplans or according to the Contractor’s approved design. The sheet piling shall be driven, as a minimum, to the tip elevation(s)

specified, prior to commencing any related excavation. If unable to reach the minimum tip elevation, the adequacy of the sheet piling design will require re-evaluation by the PMC/ Owner prior to allowing excavationadjacenttothesheetpilingin question.TheContractorshall notexcavatebelowthe maximum excavation line shown on the plans without the prior permission of the Engineer. The sheet piling shall remain in place until the Engineer determines it is no longer required.

The sheet piling shall be removed and take away from site by the Contractor when directed by the Engineer. When allowed, the Contractor may elect to cut off a portion of the sheet piling leaving the rest in place. The remaining piling shall be a minimum of 12 in. (300 mm) below the finished grade or as directed by the Engineer. Removed sheet piling becomes the property of the Contractor. When an obstruction is encountered, the Contractor shall notify the Engineer and upon concurrence of theEngineer, the Contractor shall begin working to break up, push aside, or remove the obstruction. An obstruction shall be defined as any object (such as but not limited to, boulders, logs, old foundations etc.) where its presence was not obvious or specifically noted on the plans prior to bidding, that cannot be driven through or around with normal driving procedures, but requires additional excavation or other procedures to remove or miss the obstruction.

Thefollowingaretheinstallation procedure:-

8 Thealignmentofsheetpilewallshallbecorrectlysetupfortheapprovaloftheengineer before commencing the sheet pile driving.

9 Guideframesandstakesshallbeinstalledcorrectlyandsecuredproperlytoensure drivingof piles on the centre line.

10 Steelsheetpiledrivingshallbeperformedbyoneofthefollowingmethods.

c) In driving single pile one by one, special care shall be exercised to keep each pile penetrating in strictly vertical direction.

d) In driving a group of piles (about 20 pieces simultaneously) a guide frame shall be used to keep them in a straight alignment, and in the initial stage all the piles shall be driven to a depth just enough to enable them to stand in positions. Then one or two pieces on both ends shall be driven down first, followed by the intermediate piles which shall be driven alternately in several stagesto final level.

11 Priortostartingpiledriving,theContractorshallsubmitthedrivingmethodandtimeschedulefor approval of the ENGINEER and in accordance with the sequence approved by the ENGINEER. The piles shall be driven vertically in the specified positions.

12 Piledriving:

a) Sheet pile driving shall commence initially with minimum impact of hammer and increased later after ensuring that the piles are being driven vertically in designed alignment.

b) Pile shall be driven with cap and cushion on top of the pile for protection against the impact of drop hammer.

c) Lengthening of pile, if required, shall be done by welding additional piece on to the top of pile already driven. The joints shall be as strong as the normal section of the pile.

d) In case interlocks of piles with adjacent ones are found loosened or dislocated during or after driving, such piles shall be pulled out and replaced with new ones or redone otherwise in accordance with instructions of the ENGINEER.

e) The Contractor shall take every step to ensure safety and to prevent

accident while handling and driving piles. If any deviation from specified lines, fractured top, deficient or excessive penetration is observed during pile driving, the driving shall be suspended to take corrective measures as directed by the ENGINEER.

f) Necessary data and logs such as of the number of blows, length of penetration etc. during sheet pile driving shall be made and submitted in duplicate to the ENGINEER at no extra cost. Format of driving log shall be got approved by ENGINEER prior to commencement of driving sheetpiles.

13 **Reformedsteelsheetpiles:**

Reformed steel sheet piles shall be of three types, namely corner sheet pile, junction sheet pileand wedge sheet pile.

Corner sheet piles are used where centre line for driving turns to form an angle, and joined by welding to the sheet pile wall that has changed its direction.

Junction sheet piles are those to be used where two walls of sheet piles meet at right angleforming a T junction, and where the sizes of sheet pile change along the same line.

Wedge sheet piles are used to make up for the deviation of piles from the plumb line caused during driving. This type of pile is characterized by its wedge like shape, tapering downward to the tip.

Reformed steel sheet piles as mentioned above shall as a rule is manufactured in a factory. If it becomes inevitable to fabricate them in the field at site, the Contractor shall provide equipment and manufacturing means equivalent to those of the regular factory production and have close supervision and control over driving.

If the Contractor finds it necessary to use the reformed steel sheet piles, he shall obtain approval of the ENGINEER for the use, and fabricate the same at his own cost in accordance with the instructions of the ENGINEER.

PaymentforSteelSheetPiling

It may be noted that the measurement shall be taken for one side of the trench only and the Contractor shall be paid for one side only even though sheet pilling work is provided for both sides trench in accordance with the Contract drawings or as directed by the Engineer. The unit rate for steel sheet pile driving shall include the costs of material, transportation, driving and incidental costs towardsreplacement of the damaged steel sheet piles. The cost will also include the cost of waling andaccessories.

ReinforcementWorkmanship

Reinforcingbarssuppliedbentorincoilsshallbestraightened coldwithoutdamage.Nobending shall be done when ambient temperature is below 5°C. Local warming may be permitted if steel is kept below 100° C.

Allbarsshallbeaccuratelybent graduallyandaccordingtothesizesandshapesshownonthe drawings/ schedules or as directed by the Engineer.
Re-bendingorstraighteningincorrectlybentbarsshallnotbedonewithouttheapproval ofthe Engineer.

Reinforcement shall beaccuratelyfixed and maintained firmlyin thecorrect position bythe use of blocks, spacers, chairs, binding wire etc. to prevent

displacement during placing and compactionofconcrete.Thetiedinplacereinforcementshallbeapprovedbytheengineerprior

toconcreteplacement.Spacersshallbeofsuchmaterialsanddesignsaswillbedurable,notlead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Bindingwireshallbe16 gaugesoftannealedwires.Endsofthebindingwireshallbebent away from the concrete surface and in no case encroach into the concrete cover. Substitutionofreinforcement,laps/ splicesnotshownondrawingshallbesubjecttoEngineer's approval.

Tolerances

Toleranceisaspecifiedpermissiblevariationfromlines,gradeordimensionsgivenindrawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Tolerance for formed and concrete dimensions shall be as per IS:456 unless specified otherwise.

TolerancesforR.C.Buildings

VariationfromthePlumb

(i) In thelinesandsurfacesofcolumns,piers,wallsandinarrises5mmper2.5mor25 mm, whichever is less.

(ii) Forexposedcornercolumnsandotherconspicuouslines

In any bay or 5 m maximum - 5 mm In 10 m or more - 10mm

Variationfromthelevelorfromthegradesindicatedonthe drawings

(i) Inslabsoffits,ceilings,beamsoffits,andinarises

In2.5 m - 5 mm
In any bay or 5 m maximum - 10mm
In10 mormore - 15 mm

(ii) Forexposedlintels,sills,parapets,horizontalgroovesand otherconspicuouslines: In any bay or 5 m maximum - 5 mm
In10 mormore - 10 mm

Variationofthelinearbuildinglinesfromestablishedpositioninplanandrelatedpositionof columns, wall and partitions :

Inanybayor5 m maximum -10 mm
In10 mormore - 20 mm

Variationinthesizesandlocationsofsleeves,openingsinwallsandfloors –

5mmexceptinthecase anchor bolts.

Variationincross-sectionaldimensionsofcolumnsandbeamsandinthethicknessofslabsandwalls

Minus - 5 mm
Plus - 10 mm

Footings

(i) Variationindimensionin plan Minus- 5 mm
Plus - 50 mm

(ii) Misplacementoreccentricity
2%offootingwidthinthedirectionofmisplacementbutnotmorethan50mm

(iii) Reductioninthickness
Minus- 5%ofspecifiedthicknesssubjecttoamaximumof50mm

Variationinsteps

(i) Inaflight ofstairs
Rise - 3 mm
Tread - 5 mm

(ii) Inconsecutive steps
Rise - 1.5 mm
Tread - 3.0 mm

Tolerancesinotherstructures

Allstructures

(i) Variationoftheconstructionlinearoutlinefromestablishedpositio ninplan In 5 m - 10 mm
In10 mormore - 15 mm

(ii) Variationsofdimensionstoindividualstructurefeaturesfrom established positions
In 20 m or more - 25mm In buried construction - 50 mm

(iii) Variationfromplumb,fromspecifiedbatterorfromcurvedsurfacesofallstr uctures
In2.5 m - 10 mm
In5 m - 15 mm
In10 mormore - 25 mm
Inburied construction - Twicetheabove amounts

(iv) Variationfromlevelorgradeindicatedondrawingsinslab,beams,soffits,ho rizontal grooves and visible arises.
In2.5 m - 5 mm
In7.5 mormore - 10 mm
Inburied construction - Twicetheabove amounts

(iv) Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members
Minus - 5 mm
Plus - 10 mm

(vi) Variationinthethickness ofslabs,walls,arch sectionsandsimilar members
Minus - 5 mm
Plus - 10 mm

Footingforcolumns,piers,walls,buttressesandsimilarmembers

(i) Variationofdimensioninplan

Minus	-	10 mm
Plus	-	50 mm

(ii) Misplacementoreccentricity
2%footingwidthinthedirectionofmisplacementbutnotmorethan50mm
(iii) Reductioninthickness
5%ofspecifiedthicknesssubjecttoamaximumof50mm.

Toleranceinfixinganchorboltsshallbeas follows:

(i) Anchorboltswithoutsleeves : 1.5mmin plan

(ii) Anchorboltswithsleeves : 5.0mmin elevation

- forbolts upto and including28 mm dia : 5mm in all directions
- forbolts32 mmdiaandabove : 3mmin alldirections

(iii)Embedded parts : 5mm in all directions

TolerancesinFormwork:

Theformworkshallbedesignedandconstructedtotheshapes,linesanddimensions shownon the drawings within the tolerances given below:

(i)	Deviationfromspecifieddimensionsofcross section of columns and beams	-6 mm +12 mm
(iii)	Deviations from dimensions of footings (Tolerances applytoconcretedimensionsonly, not to positioning of vertical reinforcing steel or dowels)	
	-Dimension in plan	-12 mm +50 mm
	-Eccentricity	0.02 times the width of the footing in the direction of deviationbutnotmorethan50 mm
	-Thickness	± 0.05 times thespecified thickness

PreparationPriortoConcretePlacement

Beforeconcreteisactuallyplacedinposition,theinsideoftheformworkshallbeclean edand mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements-formwork, equipment and proposed procedure, shall be approved by the Engineer.ContractorshallmaintainseparatePourCardforeachpourasperthefor matenclosed.

Transporting,PlacingandCompactingConcrete

Concrete shall be transported from the mixing plant to the formwork with

minimum time lapse bymethodsthatshallmaintaintherequiredworkabilityandwillpreventsegregation,lossofany ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearlyas practicable directlyin its final position. To avoidsegregation,concreteshallnotberehandledorcausedtoflow.Forlocationswheredirect placement is not possible and in narrow forms the Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0m. Concreteshallnotbeplacedinflowingwater.Underwater,concreteshallbeplacedinposition by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water. WhileplacingconcretetheContractorshallproceedasspecifiedbelowandalsoensurethe following:

1. Continuouslybetweenconstructionjointsandpre-determinedabutments.
2. Withoutdisturbancetoformsor reinforcement.
3. Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.
4. Withoutdroppinginamannerthatcouldcausesegregationorshock.
5. Indeeppoursonlywhentheconcreteandformworkdesignedforthispurposeandby using suitable chutes or pipes.
6. Donotplaceiftheworkabilityissuchthatfullcompactioncannotbe achieved.
7. Without disturbing the unsupported sides of excavations; prevent contamination ofconcretewith earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.
8. Ifplaceddirectlyontohardcoreoranyotherporousmaterial,dampenthesurfaceto reducelossof water from the concrete.
9. Ensurethatthereisnodamageordisplacementtosheetmembranes.
10. Recordthetimeandlocationofplacingstructural concrete.
11. Cover blocks of required size depending on the cover of the reinforcement as mentioned in the drawings should be prepared in 1:3 cement mortar with fine aggregates.
12. The top surface of each pour and bedding planes shall be approximately horizontal unless otherwise instructed. Toplayer should be rough and with key for further extension of work.
13. Concrete shall be compacted during placing with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, as specified in the IS, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement andembedded fixtures.
14. Vibrators shall conform to BIS specifications. Type of vibrator to be used shall depend on the structures where concrete is to be placed.
15. Bleeding or free water on top of concrete being deposited into the forms, shall be the cause tostop the concrete pour and the conditions causing this defect corrected before any further Concreting is resumed.

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer.Concreteshallbecompacteddduringplacingwithapprovedvibratingequipmentwithout causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork.

Immersion vibrators shall be inserted vertically at points not more than 450

mm apart and withdrawnslowlytillairbubblesceasetocometothesurface,leavingnovoids.When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers.

Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfacesafterstartofinitialset.Concretemaybeconveyedandplacedbymechanicallyoperated equipment after getting the complete procedure approved by the Engineer. The slump shall be held to the minimum necessary for conveying concrete by this method.When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

Exceptwhenplacingwithslipforms,eachplacementofconcreteinmultipleliftwork,shallbe allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the Engineer. Concrete shall be protected against damage until final acceptance.

MassConcreteWorks

SequenceofpouringformassconcreteworksshallbeasapprovedbytheEngineer. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

Curing

Curingandprotectionshallstartimmediatelyafterthecompactionoftheconcrete toprotectit from:

1. Prematuredryingout,particularlybysolarradiationandwind
2. Leachingoutbyrainandflowing water
3. Rapidcoolingduringthefirstfewdaysafter placing
4. Highinternalthermalgradients
5. Lowtemperatureorfrost
6. Vibration and impact which may disrupt the concrete and interfere with its bond to thereinforcement.

All concrete, unless approved otherwise by the Engineer, shall be cured by use of continuous spraysorpondedwaterorcontinuouslysaturatedcoveringsofsacking,canvas,hessainorother absorbent material fortheperiod of complete hydration with a minimum of 7 days. Thequality of curing water shall be the same as that used for mixing.
Where a curing membrane is approved to be used by the Engineer, the same shall be of a non- wax base and shall not impair the concrete finish in any manner. The curing compound to be usedshallbeapprovedbytheEngineerbeforeuseandshallbeappliedwithsprayingequipment capable of a smooth, even textured coat.

Curingmayalsobedonebycoveringthesurfacewithanimpermeablematerialsuch as polyethylene, which shall be well sealed and fastened.

ConstructionJointsandKeys

Constructionjointswillbeasshownonthedrawingorasapprovedbytheengineer.

Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the Engineer.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cementslurryand encasedinleanconcreteasindicatedonthedrawingsorasapprovedbythe Engineer.

Assoonastheexposedconcretehassufficientlyhardened,thesurfaceofthejointsha llbewater jetted or brushed with a stiff brush to expose the larger aggregate without being disturbed.
Roughening of the surface by chipping or hacking will not generally be approved.Before placingfreshconcreteagainstaconstructionjointallloosematerialshallberemov edandthe surface sluiced with water until it is perfectly clean, thereafter all ponded water should be removed.

Whenconcretingistoberesumedonasurfacewhichhasnotfullyhardened,alllaitan ceshallbe removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

MovementJoints

1. Movement joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision being made where necessary for maintaining the water tightness of the joint. The contractor shall comply with the instructions of manufacturersof proprietary jointing materials and shall, if required by the Engineer, demonstrate that the jointing materials can be applied satisfactorily.
2. The surface of set concretein a movementjoint shall, as shownon the drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry. Expansion joints shall be formed by a separating strip of approved preformed joint filler.
3. 3. Caulking grooves shall be provided. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried, it shall be primed and caulked with approved sealing compound applied in accordance with the manufacturer’s instructions. At all caulkedjoints,thefaceofthecaulkingstripandawidthofconcreteoneithersidesha llbepainted with two coats of paint havingthe same base as the sealingcompound.

FoundationBedding

Allearthsurfacesuponwhichoragainstwhichconcreteistobeplaced,shallbewellc ompacted and free from standingwater, mud or debris. Soft or spongyareas shall be cleaned out and back filledwitheithersoil-cementmixture,leanconcreteorcleansandcompactedasapprovedbythe Engineer. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form roughstepsorbenchesbypicking,barringorwedging.Therocksurfaceshallbekeptwetfor2 to 4 hours before concreting.

Finishes

General

Theformwork forconcrete works shall be such as to give the finish as specified. TheContractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective orpoorlycompactedconcrete)willnotbeaccepted.TheContractorshallconstruc ttheformwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

SurfaceFinishTypeF1

Themainrequirementisthatofdense,wellcompactedconcrete.Notreatmentisreq uiredexcept repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris.
Forsurfacesbelowgradewhichwillreceivewaterproofingtreatmenttheconcrete shallbefreeof surface irregularities which would interfere with proper and effective application of waterproofing material specified for use.

SurfaceFinishTypeF2

Theappearanceshallbethatofasmoothdense,well-compactedconcreteshowingtheslight marks of well fitted shuttering joints. The Contractor shall make good any blemishes.

SurfaceFinishTypeF3

This finish shall give an appearance of smooth, dense, well-compacted concrete with no shutter marks,stainfreeandwithnodiscolouration,blemishes,arises,airholesetc.Onlyli nedorcoated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by the Contractor.

UnformedSurfaces

Finishestounformedsurfacesofconcreteshallbeclassifiedas U1, U2, and U3, ‘spadedorbo nded concrete’.Where the class of finish is not specified the concrete shall be finished to Class U1.

Class U1 finish is the first stage for Class U2 and U3 finishes and for a bonded concrete surface.Class U1 finish shall be a levelled and screeded, uniform plain or ridged finish which (unless it is being convertedtoClassU2,U3,orbondedconcrete)shallnotbedisturbedinany wayaftertheinitialsetand during the period of curing, surplus concrete being struck off immediately after compaction.

Whereabondedconcretesurfaceisspecified,thelaitanceshallberemovedfromtheClassU 1finished surface and the aggregate exposed while the concrete is still green.
Aspadedfinishshallbeasurfacefreefromvoidsandbroughttoareasonablyuniformappear ancebythe use of shovels as it is placed in the Works.

ClassU2finishshallbeawoodfloatfinish.Floatingshallbedoneaftertheinitialsetoftheconcretehas taken place and the surface has hardened sufficiently.The concrete shall be worked no more than is necessary to produce a uniform surface free from screed marks.

Class U3 finish shall be a hard smooth steel-trowelled finish.Trowelling shall not commence until the moisturefilmhasdisappearedandtheconcretehashardenedsufficientlytopreventexcesslaitancefrom being worked into the surface.The surfaces shall be trowelled under firm pressure and left free from trowel marks.

Theadditionofdrycement,mortarorwatershallnotbepermittedduringanyoftheabove operations.

IntegralCementFinishonConcreteFloor

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concreteshallbescreededofftoproperlevelandtampedwithtampersothattheaggregateshall beforcedbelowthesurface.Thesurfaceshallbefinishedwithawoodenfloatandatrowelwith pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the Engineer shall be supplied and used as recommended by the manufacturer.

RepairandReplacementof UnsatisfactoryConcrete

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces,roughpatches,andholesleftbyformboltsetc.shallbeinspectedbytheEngineerwho may permit patching of the defective areas or reject the concrete work.

Allthroughholesforshutteringshallbefilledforfulldepthandneatlypluggedflush with surface.

Rejectedconcreteshallberemovedandreplacedbythe Contractoratnoadditionalcosttothe Employer.

Forpatchingofdefectiveareasallloosematerialsshallberemovedandthesurfaceshallbe prepared as approved by the Engineer.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar with approved bonding agent or by applying epoxy. The decision of the Engineer as to the methodofrepairstobeadoptedshallbefinalandbindingontheContractor.Thesurfaceshallbe saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the Engineer. Alltheformboltrepairsanddelayedrepairsshallbecarriedoutusingaproportionofwhite cement in repair mix to the approval of the Engineer, so as to match the colour of the surrounding area.

VacuumDewateringofSlabs

Where specified floor slabs, either grade or suspended, shall be finished by

vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating andtrowellingasperequipmentmanufacturersrecommendation.Theequipmen ttobeusedshall be subject to the Engineer’s approval.

HotWeatherRequirements

Concretingduringhot weathershallbecarriedout asper IS: 7861(PartI).

Adequateprovisionsshallbemadetolowerconcretetemperatureswhichshallnot exceed33°C at the time of placement of fresh concrete.

WheredirectedbytheEngineer,theContractorshallspraynon-waxbasedcuringcompoundon unformed concrete surfaces at no extra costs.

LiquidRetainingStructures

TheContractorshalltakespecialcareforconcreteforliquidretainingstructures,underground structures and those others specifically called for to guarantee the finish and water tightness.

TheminimumlevelofsurfacefinishforliquidretainingstructuresshallbeTypeF2.Allsuch structures shall be hydro-tested.

TheContractorshallmakeallarrangementsforhydro-testingofstructure,allarrangementsfor testing such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.

Anytemporaryarrangementsthatmayhavetobemadetoensurestabilityofthestructuresshall also be considered to have been taken into account while quoting the rates.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period orthe period for which the structureis guaranteed shall beeffectivelystopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the Engineer.AllsuchrectificationshallbedonebytheContractortotheentiresatisfactionofthe Employer/Engineer at no extra cost to the Employer.

TestingConcreteStructuresfor Leakage

Hydro-statictestforwatertightnessshallbedoneatfullstoragelevelorsoffitofcoverslab, as may be directed by the Engineer, as described below:
Incaseofstructureswhoseexternalfacesareexposed,suchaselevatedtanks,therequirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

In the case of structures whose external faces are buried and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling; the level of the surface of the water shall be recorded. The level of water shallberecordedagainatsubsequentintervalsof24hrs.overaperiodofsevendays.Backfilling shall be withheld till the tanks are tested. The total drop in

surface level over a period for seven days shall be taken as an indication of the water tightness of the structure. The Engineer shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation

losses.Unlessspecifiedotherwise,astructurewhosetopiscoveredshallbedeemed tobewater tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

Eachcompartment/segmentofthestructureshallbetestedindividually. For structures such as pipes, tunnels etc. the hydrostatic test shall be carried out by filling with water,aftercuringasspecified,andsubjectingtothespecifiedtestpressureforsp ecifiedperiod. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

OptionalTests

If the Engineer is not satisfied with the results of the tests under Clause 4.5 or otherwise considersthatthematerialsi.e.cement,sand,coarseaggregates,reinforcement andwaterarenot in accordance with the Specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the Engineer, as per relevant IS Codes.Contractor shall have to pay for these tests.

In the event of any work being suspected of faulty material or workmanship requiring its removaloriftheworkscubesdonotgivethestipulatedstrengths,theEngineerres ervestheright to order theContractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. The Engineer also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Employer. IfthestructureiscertifiedasfailedbyEngineer,thecostofthetestandsubsequent dismantling/reconstruction shall be borne by the Contractor.

Thequoted unit rates/pricesof concreteshallbedeemed toprovideforalltests mentioned above.

AcceptanceCriteria

Anyconcrete work shallsatisfytherequirementsgiven below individuallyand collectivelyfor it to be acceptable.

a) Propertiesofconstituent materials;
b) Characteristiccompressive strength;
c) Specifiedmixproportions;
d) Minimumcementcontent;
e) Maximumfree-water/cement ratio;
f) Workability
g) Temperatureoffreshconcrete;
h) Densityoffullycompactedconcrete;
i) Covertoembeddedsteel;
j) Curing;
k) Tolerancesindimensions;
l) Tolerancesinlevels;

m) Durability;
n) Surfacefinishes;
o) Specialrequirementssuchas;
    i) Water tightness
    ii) Resistancetoaggressive chemicals

iii) Resistanceto freezingand thawing
iv) Veryhigh strength
v) Improvedfire resistance
vi) Wearresistance
vii) Resistanceto earlythermal cracking

TheEngineer'sdecisionastotheacceptabilityorotherwiseofanyconcreteworks hallbefinal and binding on the Contractor.

For work not accepted, the Engineer may review and decide whether remedial measures are feasiblesoastorendertheworkacceptable.TheEngineershallinthatcasedirectt heContractor to undertake and execute the remedial measures. These shall be expeditiously and effectively implemented by the Contractor. Nothing extra shall become payable to the Contractor by the Employer for executing the remedial measures.

ModeofMeasurementandPayment

Theunitrateforconcreteworkundervariouscategoriesshallbeallinclusiveandn oclaimsfor extra payment on account of such items as leaving holes, embedding inserts, etc. shall be entertained unless separately provided for in the Schedule of Quantities.No extra claim shall also be entertained due to change in the number, position and/or dimensions of holes, slots or openings, sleeves, inserts or on account of anyincreased lift, lead of scaffolding etc.All these factors should be taken into consideration while quoting the unit rates.Unless provided for in the Schedule of Quantities the rates shall also include fixing inserts in all concrete work, whenever required.

Payments for concrete will be made on the basis of unit rates quoted for the respective items in the Schedule of Quantities.No deduction in the concrete quantity will be made for reinforcements, inserts etc. and opening less than 0.100 of a sq.m. and 0.010 cu.m where concrete is measured in cu.metres.Where no such deduction for concrete is made, payment for shuttering work provided for such holes, pockets, etc. will not be made.Similarlythe unit rates forconcreteworkshallbeinclusiveorexclusiveofshutteringasprovidedforinthe Scheduleof Quantities.

Payment for beams will be made for the quantity based on the depth being reckoned from the undersideoftheslabsandlengthmeasuredasthecleardistancebetweensupports. Paymentfor columns shall be made for the quantity based on height reckoned upto the underside of slabs/beams.

The unit rate for precast concrete members shall include formwork, mouldings, finishing, hoisting and setting in position including setting mortar, provision of lifting arrangement etc. complete.Reinforcementandinsertsshallbemeasuredandpaidforseparatelyun

derrespective item rates.

Onlytheactualquantityofsteelembeddedinconcreteincludinglapsasshownondrawingsoras approved byEngineer shall be measured and paid for, irrespective of the level or height at which

theworkisdone.Theunitrateforreinforcementshallincludeallwastages,binding wires, chairs, spacer bars etc.For which no separate payment shall be made.

Where the formwork is paid for separately, it shall be veryclearlyunderstood the payment for formworkisinclusiveofformwork,shuttering,shoring,proppingscaffoldingetc. Onlythenet area of concrete formed (shuttered) shall be measured for payment.

Waterstops

Material

The material for the PVC waterstops shall be a plastic compound with the basic resin of polyvinylchlorideandadditionalresins,plasticizers,inhibitors,whichsatisfiesth eperformance characteristics specified below as per IS:12200. Testing shall be in accordance with IS: 8543.

a) Tensilestrength : 11.6 N/mm^{2}minimum
b) Ultimateelongation : 300%minimum
c) Tearresistance : 4.9N/mm^{2}minimum
d) Stiffnessinflexure : 2.46 N/mm^{2}minimum
e) Acceleratedextraction
   i) Tensilestrength : 10.50 N/mm^{2}minimum
   ii) Ultimateelongation : 250%minimum
(f) EffectofAlkali : 7 days
   i) Weight increase :
   0.10%maximum ii Weight decrease :
   0.10% maximum
   iii) Hardnesschange : ± 5 points
(g) EffectofAlkali : 28 days
   i) Weightincrease : 0.40%maximum
   ii) Weightdecrease : 0.30%maximum
   iii) Dimension change : ±1%

PVCwaterstopsshallbeeitherofthebartype,serratedwithcentrebulbandendgrip sforuse within the concrete elements or of the surface (kicker) type for external use.
Flexible water stops shall be fully supported in the formwork, free of nails and clear of reinforcementandotherfixtures.Damagedwaterstopsshallbereplacedandduri ngconcreting care shall be taken to place the concrete so that water stops do not bend or distort.
PVCwaterstopsshallbeofapprovedmanufacture.Samplesandthetestcertificates hallbegot approved by the Engineer before procurement for incorporation in the works.

Workmanship

Waterstopsshallbecleanedbeforeplacingtheminposition Oilorgreaseshallberem oved thoroughly using water and suitable detergents.

Waterstops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing.Lappingofwaterstopsshallnotbepermitted.Alljointingshallbeoffusion weldedtype as per manufacturer's instructions.

Waterstops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting andvibrating.Particularcareshallalsobetakentoensurethatnohoney-combingoccursbecause of the serrations/end grips. Projecting portions of the waterstops embedded in concrete shall be thoroughlycleanedofallmortar/concretecoatingbeforeresumingfurtherconcreting operations. The projecting waterstop shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets.

Measurement

Measurementshallbeinrunningmetrescorrecttotwoplacesofdecimal.Noseparatepayment shall be made for joints or intersection pieces.

Curing,Protecting,RepairingandFinishing

Curing

All concreteshallbecuredbykeepingit continuouslydampfortheperiodoftimerequiredforcomplete hydration and hardening to take place. Preference shall be given to the use of continuous sprays, or pondedwater,continuouslysaturatedcoveringsofsacking,canvas,hessainorotherabsorbentmaterials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

CuringwithWater

Freshconcreteshallbekeptcontinuouslywetforaminimumperiodof10daysfromthedateofplacing of concrete, following a lapse of 12 to 14 hours after laying of concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin as soon as the concrete has hardened. Water shall beappliedtoformedsurfacesimmediatelyuponremoval offorms.Quantityofwaterappliedshall be controlled so as to prevent erosion of freshly placed concrete.

ContinuousSpraying

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliancesofhose,sprinklersandsprayingdevices.Continuousfinemistsprayingorsprinklingshallbe used, unless otherwise specified or approved by the Engineer.

AlternateCuringMethods

Whenever in the judgment of the Engineer, it is necessary to omit the continuous spray method, a covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used.

No type of covering will be approved which would stain or damage the concrete during or after the curing period. Covering shall be kept continuously wet during curing period. For curing of concrete in sidewalks, floors, flat roofs of other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Engineer.Specialattentionshallbegiventoedgesandcornersoftheslabstoensureprope rprotectionto these areas. The ponded areas shall be kept continuously filled with water during the curing period.

Curing Compound

Surface coating type-curing compounds shall be used only by special permission of Engineer. Curing compoundsshallbeliquidtypewhitepigmented,confirmingtoUSBureauofReclamation specification. No curing compound shall be used on surfaces where future blending with concrete, water of acid proof membrane or painting is specified.

Curing Equipment

Allequipmentandmaterialsrequiredforcuringshallbeonhandandreadyforusebeforec oncrete is placed.

`ProtectingFresh Concrete

Freshconcreteshallbeprotectedfromdefacementsanddamageduetoconstructionoper ationsbyleaving formsinplaceforanampleperiod.Newlyplacedconcreteshallbeprotectedbyapproved meanssuchas tarpaulins from rain, sun and winds. Steps as approvedbythe Engineers hall also be taken to protect immature concretefrom damage bydebris, excessivelading, vibration, abrasion or contact with other materials, etc. that mayimpair thestrength and/or durabilityof the concrete. Workmen shall be warned against and preventedfromdisturbing greenconcrete duringits settingperiod. If it is necessarythat the workmen enter the area of freshlyplaced concrete,the Engineer mayrequirethat bridges be placed over the area.

RepairandReplacementofUnsatisfactoryConcrete

General

Immediatelyafter the shutteringis removed, thesurface of concrete shall be verycarefullyinspectedand all defective areas attended to by the Engineer may permit patching of the defective areas or reject the concrete unit either partially or entirely. Rejected concrete shall be removed and replaced by the contractor.Holesshall befilledwith mortarcomposedofonepartofcementtooneandhalfpartsofsand passing 2.36 mm IS sieve after removing any loose stones adhering to the concrete. Concrete surfaces shall be finished as described in specifications or as directed bythe Engineer. Superficial honeycombed surfaces andrough patches shall be similarly made good immediatelyafter removal of shuttering,inthe presence of the Engineerand superficial water and air holes shallbefilled in.The mortar shall be well worked intothe surface with a wooden float. Excess watershall be avoided. Unless instructed otherwise by the Engineer, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shutteringto remove fine or other irregularities, care beingtakento avoid damagingthe surface. Surfaceirregularitiesshall be removed by grinding. Ifreinforcementisexposedor the honeycombingoccurs at vulnerable positions e.g. ends of beams or columns, it may be necessaryto cut out the member completely or in part andreconstruct.The decision of the Engineer shall be final in thisregard.Ifonlypatchingisnecessary,theedgesbeingcutperpendiculartotheaffected surfaceorwith asmallundercutifpossible.Anchors,teesordovetailslotsshallbeprovidedwhenevernec essarytoattach the newconcrete securely in place. An area extending several centimeters beyond the edges and the surfacesofthepreparedvoidsshallbesaturatedwithwaterfor24hoursimmediatelybefo rethepatching material is placed.

UseofEpoxy

Theuseofepoxyforbondingfreshconcreteusedforrepairswillbepermitteduponwritten approvalof the Engineer. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

MethodofRepair

Smallsizeholeshavingsurfacedimensionsaboutequaltothedepthofthehole,holeslefta fterremoval of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows.

The hole to be patched shall be roughened and thoroughly soaked with clean water until absorptionstops. A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly protrude of the surrounding surface. The concrete patch shall be built up in 10 mm thick layers, after an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. A steel trowelshallbeusedforthispurpose.Themixforpatchingshallbeofthesamematerialsan dinthesame proportion as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessaryandthe mix shall be keptas dryas possible.Mortar fillingbyair pressure (gunniting) shall be used for repair of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by the Engineer, to match the shade of the patch with the original concrete.

CuringofPatchedWork

The patched area shall be covered immediately with an approved non-staining, water-saturated material suchasgunnybagswhichshallbekeptcontinuouslywetandprotectedagainstsunandwin dforaperiod of 24 hours.Thereafter,the patched area shall be kept wet continuouslybya finespray, or sprinklingfor not less than 10 days. All fillings shall be tightly bounded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

ApprovalbytheEngineer

Allmaterials,proceduresandoperationsusedintherepairworkshallbesubjecttotheappro valofthe Engineer.

PrecastConcrete

General

Precast concrete units, whether manufactured on or off site, shall comply in every way with the provisions of the contract for in situ concrete. Wherever possible, precast units shall be hydraulically pressed.Whenreadyforincorporationintheworks,precastunitsshallberesponsiblefor theaccuracyof the level, shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

StrikingForms

Sideshuttersshallnotbestruckinlessthan24hoursafterdepositingconcreteandnoprec astunitshall be lifted until the concrete reaches strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.

PrecastUnits

Theliftingandremovalofprecastunitsshallbeundertakenwithoutcausingshock,vibratio
norundue
bendingstressestoorintheunits.Beforeliftingandremovaltakesplace,contractorshallsat
isfythe
Engineerorhisrepresentativethatthemethodsheproposestoadoptfortheseoperationswi
llnotover-

stressorotherwiseeffectseriouslythestrengthoftheprecastunits.Thereinforcedsideof theunitsshall be distinctly marked.

Curing

All precast workshall be protectedfromthe direct rays of the sun for at least 7 days after castingand duringthatperiodeachunitshall bekept constantlywateredorpreferablybecompletelyimmersedin water if the size of the unit so permits.

Slots,Openings,etc.

General

Slots,openingsorholes,pockets,etc.,shallbeprovidedintheconcreteworkintheapprov edpositionsor asdirected byEngineer. Short pipes with puddle collar shall be fixed in the sidewall of suction pipes.
They shall be supplied at the appropriate time during construction. Anydeviation from the approved drawingsshallbemadegoodbycontractoratownexpense,withoutdamaginganyotherwor k.Sleeves, bolts, inserts etc., shall also be provided in concrete work where so required.

Grouting

StandardGrout

Grout shall be provided as specified on the drawings.The proportion of StandardGrout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage.Surfaces to be grouted shall be thoroughly roughened and cleaned.All Structural steel elements to be grouted shall be cleaned of oil, grease, dirt etc.The use of hot, strong caustic solution for this purpose will be permitted.
Priortogrouting,thehardenedconcreteshallbesaturatedwithwaterandjustbeforegrou tingwaterinall pockets shall be removed.Grouting once started shall be done quickly and continuously.Variation in grout mixes and procedures shall be permitted if approved by Engineer.The grout proportions shall be limited as follows:

Use	GroutThickness	MixProportions	W/ CRatio (max)
a)Fluid mix	Under25mm	OnepartPortlandCement to one part sand	0.4
b)Generalmix	25mmandoverbut less than 50mm	OnepartPortlandCement to 2 parts of sand	0.53
c)Stiffmix	50mmandover	OnepartPortlandCement to 3 parts of sand	0.53

Non-ShrinkingGroutforEquipmentFoundation

Non-shrinking grout shall be used for grouting of machine base plates, anchor

bolts, other anchoring devicesandatlocationswhereordinarygroutsareineffectiveduetoshrinkage.Itshallbecomposedofa type of expansive hydraulic sheeting binder and select-graded aggregates. It shall have properties as per “*Table 11: Proportions for Non-Shrinking Grout*”.

Table11:ProportionsforNon-ShrinkingGrout

S.No.	Properties	Values
1	Maximumgrainsize	6 mm
2	Water%(for80%flow)	15.17
3	Densityofhardenedgrout	2.27–2.30gm/m
4	CompressivestrengthN/sqmm	
	Minimum3days	23
	7days	34

Mixing,batching,cleaning,preparationofsurfaceandcuringofnon-shrinkinggroutshallbedone as per manufacturer's instructions.

Inspection

d. All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer.
e. All materials supplied by the Contractor and all work or construction performed by the Contractor which is rejected as not being in conformity with the specifications and requirements, shall be immediately replaced.
f. AllconcreteshallbeprotectedagainstdamageuntilfinalacceptancebytheEngineer.

Clean-up

d. Upon completion of the concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.
e. All debris i.e. empty containers, scrap wood, etc., shall be removed to "dump" daily, or as directed by the Engineer.
f. Thefinishedconcretesurfacesshallbeleftinacleanconditionsatisfactorytothe Engineer.

PreformedFillersandJointSealing Compound

Materials

Preformedfillerforexpansion/isolationjointsshallbenon-extrudingandresilienttypeof bitumen impregnated fibres conforming to IS: 1838 (Part I).
Bitumencoattoconcrete/ masonrysurfacesforfixingthepreformedbitumenfillerstripshall conform to IS: 702.Bitumen primer shall conform to IS: 3384.
Sealantsshall beofthe followingtypes:

SealantTypeA

Sealant Type A shall be a gun grade, non-slumping compound suitable for sealing horizontal, verticalandsoffitjointsinwaterretainingstructures.ItshallbeaUKWFBSmaterialapproved forunrestricteduseincontactwithpotablewatertothefullexposureconditionof15000mm^2/l, and shall not support bacterial growth.
Itshallbestableandshallhavealowwaterabsorptionandgoodadhesiontoconcrete. Hardness (Shore A) : > 12
TransverseMovementAccommodation: ±15%

SealantTypeB

Sealant type shall be a gun grade compound, suitable for sealing vertical movement and constructionjointsinconcretestructures.Itshallbeflexible,resistanttoaging,physicaldamage and weathering and shall have good adhesion to concrete.
Hardness (Shore A) : > 12
Transverse Movement Accommodation:
±12.5%

SealantTypeC

Sealant type C shall be similar to Type B above.In addition it shall have been designed for sealingmovementandconstructionjointsinhydraulicandwaterretainingstructuresandshallbe suitable for use in contact with potable water.
Hardness (Shore A) : > 20
Transverse Movement Accommodation:
±12.5%

SealantTypeD

Sealant Type D shall be a pourable compound suitable for sealing horizontal movement and constructionjointsinconcretestructures.Itshallbeflexible,resistanttoaging,physicaldamage and weathering and shall have good adhesion to concrete.
Hardness (Shore A) : > 9
Transverse Movement Accommodation:
±12.5%

SealantTypeE

Sealant Type E shall be a cold pouring compound complying with BS 5212, suitable for sealing movement and construction joints in concrete paved areas.It shall be resistant to fuels, oils and hydraulicfluids.Itshallbetough,abrasion-resistantandshallnotdecomposeinstrongsunlight. Hardness (Shore A) :
> 12
TransverseMovementAccommodation: ±12.5%

ApprovedSealants

The following approved sealants meet the above specifications. Sealant Type A, B and C :
Thioflex 600 gun grade
Sealant Type :
Thioflex600pourablegrade
SealantTypeE : Colpor 200

ThehardnessvaluespecifiedintheabovesummariesistheShoreADurometervalueat14days at 25° C and 50% RH.The specified transverse movement values are based on joints having a width to depth ratio of 1.5: 1.

TheContractor mayusetheabovesealantsor onesmeetingequivalentor higher specifications.

Workmanship

Thethicknessofthepreformedbitumenfillershallbe25mmforexpansionjointsand 50mmfor isolation joints around foundation supporting rotatory equipments. Contractor shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.

Theconcrete/ masonrysurfaceshallbecleanedfreefromdustandanylooseparticles.Whenthe surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS:702 shall be applied hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surfaceof thefiller against which further concreting/masonrywork is to be doneshall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/sq.m.

Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concretejointshallbeappliedhotwithacoatofbitumenprimerconformingtoIS:3 384inorder to improve the adhesive quality of the sealing compound.

Expansion joints between beams/slabs shall be provided with 100mm wide x 4mm thick mild steelplateatthesoffitofRCCbeams/slabstosupportandpreventthepreformedjoi ntfillerfrom dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

TheContractorshallconstructrecessesatalljointsandonbothfacesoftheconcrete workexcept on the underside of ground slabs.The recesses shall be accurately formed to the lines and dimensions shown on the Drawings or as agreed with the Engineer.

TheContractorshallpreparethesurfacesoftherecessandshallsupplyajointsealer andfillor caulk the recess completely with it.

JointsealingshallnotbecommencedwithouttheapprovaloftheEngineer.Inres ervoirjoints the sealershall bepoured after completion ofthe watertightness test, to the satisfaction ofthe Engineer.

All joint sealers shall be from an approved manufacturer.The Contractor shall supply the manufacturer’stestcertificatesforeachconsignmentofeachtypeofjointsealantd eliveredtothe Site and shall if requested supply to the Engineer sufficient samples of each type and consignment for confirmatory tests to be carried

out in accordance with the appropriate test procedure.

Sealants shall be installed in strict accordance with the manufacturer’s instructions.De-bonding strip shall be used in conjunction with the sealers as indicated on the Drawings.The de-bonding stripshallbecompatiblewiththejointsealerandshallberesistanttoattachfromth eprimerused to bond the sealer to the concrete.

Polysulphide and polyurethane sealants shall not abut bitumen sealers. Surfaces to receive Polysulphideandpolyurethanesealantsshallbekeptfreefrombituminouspaints. Allsealants shall be appropriate for the prevailing climatic conditions.Bituminous sealants shall comply with the BS 2499 for Type A1. Polysulphide sealants shall comply with IS 12118.

Measurement

Measurementforthepreformedjointfillershallbeinsq.mcorrecttotwoplacesof decimalfor the specified thickness as per items of work. Measurement for applying the bitumen coat to concrete/masonrysurfaces shall be in sq.m correct to two places of decimal. Measurement for the joint sealing compound shall be in running metres correct to two places of decimal for the specified width and thickness as per the items of work. Measurement for the mild steel corner angle and plate shall be by weight as per the items of work.

ConcretingRecords

AwrittenrecordoftheconcreteworksshallbemadeeachdaybytheContractoran dkept available for inspection by the Engineer.The diary shall contain notes and records of:

1. **ThenamesoftheContractor'sEngineerwhoareresponsibleforthedifferentphase s of the concrete work and also the names of their assistants.**

2. **Thetemperaturesofair,water,cement,aggregate,togetherwiththeairhumiditya nd type of weather.**

3. **DeliveriestotheSiteofconcretematerials(quantity,brandofconcrete,etc).**

4. **Inspectionscarriedout,testsperformed,etc.andtheirresults.**

5. **Times of commencement and completion of different parts of the concrete works and timesof erection and striking of forms.**

6. **Quantity of cement, fine and coarse aggregate and admixture used for each section of work and the number and kind of test samples taken on these ingredients and water.**

CONCRETEPOURCARD

CLIENT	:		DATE	:	POURNO.:
PROJECT	:		STRUCTURE:		

Contractor : MAX.AGGREGATESIZE/SLUMP:
DRG. NO. : START/COMPLETIONTIME: /
CONCRETEGRADE/QUANTITY: MIXINGTIME:
/

SL. NO.	ITEM		Contractor ’sRep. Sign	Engineer’sSign	Remarks
1.	BEFORE CONCRETING	CENTRELINESCHECKED			POUR AUTHORISED SITE ENGINEER
2.		FORMWORK AND STAGING CHECKED FOR ACCURACY,STRENGTH & FINISH			
3.		REINFORCEMENT CHECKED			

4.		COVERTO REINFORCEMENT CHECKED				
5.		VERIFIEDTEST CERTIFICATEF OR CEMENT/STEEL		YES/ NO	YES/ NO	
6.		ADEQUACY OF MATERIALS/EQUIPME NT FORPOUR		YES/ NO	YES/ NO	
7.		EMBEDDED PART S	CIVIL			
		CHECKED	MECHANI CAL			
		(LOCATION& PLUMB)	ELECTRI C AL			

8.	SOFFIT(S)&POURTOP(T) LEVELSCHECKEDBEFORE(B) &AFTER(A) FORMREMOVAL (ONLYOFBEAMSOFOVER10 M SPAN&IMPORTANT STRUCTURELIKET.G. ETC.)	S(B) T(B) S(A) T(A)	
9.	CONSTRUCTION JOINTS LOCATION&TIME(IFNOTAS PER DRAWING)		
10.	CEMENTCONSUMPTIONIN KGS.		
11.	NUMBEROFCUBESAND IDENTIFICATIONMARKS		
12.	TESTCUBERESULTS (7DAYS/ 28 DAYS)		
13.	CONCRETECONDITIONON FORM REMOVAL	V.GOOD/GOOD/FAIR/ POO R	

SITE-IN-CHARGE

NOTES :1. EACHITEMTOBECHECKEDANDSIGNEDBYTHERESPECTIVE ENGINEERS.

2. ITEMS8TO13 (BOTHINCLUSIVE)TOBEFILLEDONLYBYENGINEER.

3. EACHPOURTOHAVESEPARATECARDS,INTRIPLICATEONEEACHFORC LIENT, CONSULTANT & SITE OFFICE.

UNDER REMARKS INDICATE DEVIATIONS FROM DWGS. & SPECIFICATIONS, CONGESTIONINREINFORCEMENTIFANY,UNUSUALOCCURENCES,SUCH AS FAILURE OF EQUIPMENTS, SINKING OF SUPPORTS / PROPS. HEAVY RAINS AFFECTING CONCRETING, POOR COMPACTION, IMPROPER CURING, OTHER DEFICIENCIES, OBSERVATIONS ETC.

EndofSection-4

SECTION 5

ROADSANDDRAINS

SECTION5

ROADSANDDRAINS

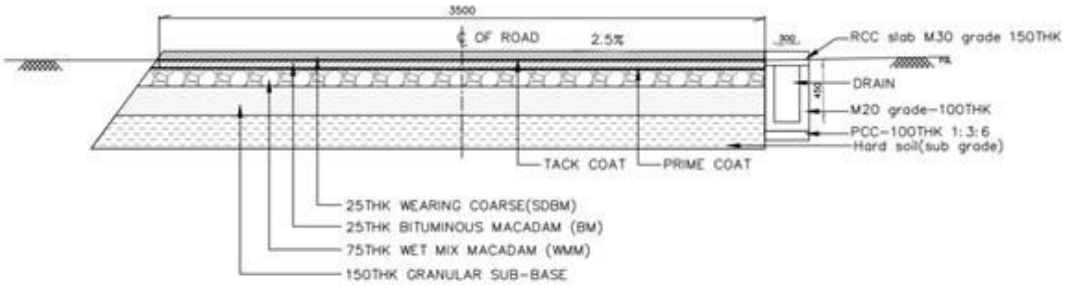
Definitions

ThewordslikeContract,Contractor,Engineer(synonymouswithEnginee r-in-charge), Drawings, Employer, Government, Works and Work Site used in these Specifications shall be considered to have the meaning as understood from the definitions of these terms given in the General Conditions of Contract.

Thefollowingabbreviationsshallhavethemeaningassetforth below:

MORTH : MinistryofRoadTransportandHighways
IRC : Indian Roads Congress
IS : IndianStandardpublishedbytheBureauofIndianStandards
GSB : Granular Sub Base
WMM : WetMix Macadam
BM : BituminousMacadam
BC : BituminousConcrete
CBR : CaliforniaBearingRatio
AASHTO : AmericanAssociationofStateHighwayandTransportationOfficials
ASTM : American Society for Testing and Materials
BS : British Standard published by the British Standards Institution

The various elements in the cross-section of a roadreferred to in these Specifications are shown in thecross-sections in **Fig. 5-1**.



TYPICAL CROSS SECTION OF NEW ROAD FORMATION – STP

Fig.5-1:ProposedTypicalCrossSectionoftheRoad

ApplicableCodesandSpecifications

Thefollowingspecifications,standardsandcodesarereferredtointhispart.

IS:460 :SpecificationforTestsieves

(Parts1to3)

IS:1077 :Commonburntclaybuildingbricks -Specification

IS : 1124 :Methodoftestfordeterminationofwaterabsorption,apparentspecificgravity and porosity of natural building Aggregates / stones

IS:1195 :SpecificationforBitumenMasticfor Flooring

IS:1196 :CodeofPracticeforLayingBitumenMastic Flooring

IS : 1834 :SpecificationforHotAppliedSealingCompoundsforJointsin Concrete IS : 2386 :Methods of test for aggregates for concrete (Parts1to 8)

IS : 2720 :MethodofTestforSoilsfordeterminationofLiquidandplasticlimit. (Part 5)

IS : 6241 :Methodoftestfordeterminationofstrippingvalueofroadaggregates. IRC : 16 :Specification for priming of Base Course with Bituminous Primers.

IRC : 17 :Tentative specification for Single Coat Bituminous Surface Dressing IRC : 19 :Standardspecificationsandcodeofpracticeforwaterbound macadam IRC : 29 :Specification for bituminous concrete (Asphaltic Concrete) forroadpavement.

MORTH

Specifications:MinistryofRoadTransportandHighwaysSpecificationsforRoadandBridge works

SECTION-100: GENERAL

SECTION-

300:EARTHWORK

SECTION-401:GRANULARSUBBASE

SECTION-406 : WET MIX

MACADAM SECTION-

504:BITUMINOUSMACADAM

SECTION-

507:BITUMINOUSCONCRETE

Road Configuration

Theroadsshallbeinstalledinlayersasper Drawingoverthebackfillasperconcernedsecti onsof MORTH. In Plant premise all the motorable road width is minimum 3.5m. OnlayingofPumpingmain/ sewerlinesinthetrenches,theroadsshallberestoredtoitsoriginal condition in layers as per Drawing over the back fill as per concerned sections of MORTH

Technicalspecification:

a) Backfilloverthewaterlines/

sewerlinestothedesiredlevelasperdrawingand specification.

b) Approved soil compacted in layers as per drawing, using soil deposited at site from road cutting and excavation to achieve compaction level Table 300-2 and Section 301 of MORTH Technical specification.

c) Layerofsand/stonedustasperdrawingtoachieve97%relativecompaction of

laboratorydrydensitytomeetrequirementoftable300-2of MORTH specification.

d) GranularSubbaseaspersection401ofMORTH specification.

e) Wetmixmacadam(WMM)aspersection406ofMORTHspecification.

f) Bituminousmacadam(BM)aspersection504ofMORTHspecification.

g) Bituminousconcrete(BC)aspersection507ofMORTHspecification.

Materials

General

Allmaterialsshallbeobtainedfromlocalsourcesandshall conformtotechnicalspecificationsandbe subject to Engineer's approval prior to use.

ApprovedsoilforSubgrade/ Embankment

Thematerialsusedinembankments,subgradesandmiscellaneous backfillsshallbesoil,moorum, gravel, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/ subgrade.

TheContractorshallcarryouttheexcavationin suchamannerthattheacceptablematerialsareexcavated separately for use in backfill/restoration works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

It shallbeensured thatthesubgrade materialwhencompacted to thedensityrequirementsasin**Table 5.1** (AsperTable300-2ofMORTHspecification)shallyieldthedesignCBRvalueofthesubgrade.

Table5.1:CompactionrequirementforSubgrade (As per Table 300-2 of MORTH Specification)

Typeof work/material		**Relativecompactionas %ofmax.labdry density as per IS: 2720 (Part 8)**
1	Subgradeandearthen shoulders	Notlessthan97
2	Embankment	Notlessthan95

The Contractor shall at least 7 working days before commencement of compaction submit the followingto the Engineer for approval:

i) The values of Maximum Dry Density and Optimum Moisture Content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.
ii) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.
iii) The Dry density-moisture content - CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8)and intermediate in-between the two) for eachof the fill materialshe intends to use inthe subgrade.

OncetheaboveinformationhasbeenapprovedbytheEngineer,itshallformthebasisfor compaction.

GranularSub Base

Thematerialtobeusedfortheworkshallbenaturalsand,murum,
gravel,crushedstone,orcombination thereof depending upon the grading required.
Materials like crushed slag crushed concrete, brick metal

and kankar may be allowed only with the specific approval of the Engineer. The material shall be free fromorganicorotherdeleteriousconstituentsandconformtograding-iiigivenin**Table5.2:Gradation for coarse graded granular Sub base.** (As per Table 400-1 of MORTH Specifications).

The CBR shall be determined at the density and moisture content likely to be developed in equilibriumconditions,whichshallbetakenasbeingthedensityrelatingtoauniforma ir,voids content of 5 per cent.

Table5.2:GradationforcoarsegradedgranularSubbase. (As per TABLE 400–1 of MORTH Specification)

IS Sieve	**PercentbyweightpassingtheISSieve**		
Designation	**GradingI**	**GradingII**	**GradingIII**
75.0 mm	100	-	-
53.0 mm	80-100	100	100
26.5 mm	55 -90	70-100	55-75
9.50 mm	35-65	50-80	-
4.75 mm	25-55	40-65	10-30
2.36 mm	20-40	30-50	-
0.425 mm	10-15	10-15	-
0.075 mm	<5	<5	<5
CBRValue(Minimum)	30	25	20

Note:The material passing 425 micron (0.425 mm) sieve for all the three gradingswhen tested accordingto IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

Coarse Aggregates

Coarse aggregate, stone chippings shall consist of natural or crushed stone, clean, hard, tough, durable and free fromexcess of flat, elongated, soft and disintegrated particles, dirt,salt,alkali, vegetable matter,

adherentcoatings,organicandotherobjectionablematter,andshallconformtothephysi calrequirements given in **Table 5.3** and **Table 5.4** hereunder, as applicable.
Aggregate for bituminous wearing courses

shall in addition have good hydrophobic properties i.e. capacity of retaining the film of bituminous materialappliedtothestoneinallweatherconditionsandespeciallyinwetconditions.Basalt,dolerites are good in this respect; granite, quartzites are comparatively poor.

ble–5.3: Physical Requirements of Coarse Aggregate for Wet Mix Macadam(W MMSl. No	**Test**	**Requirements**	**TestMethod**
1.	LosAngelesAbrasionValue*	40percent(max.)	IS:2386(Part–IV)
	Or		
	AggregateImpactValue*	30percent(max.)	IS:2386(Part–IV)
			Or
			IS:5640***
2.	FlakinessIndex**	15percent(max.)	IS:2386(PartI)
3.	CombinedFlakinessand Elongation Indices**	35percent(max.)	IS:2386(PartI)

(*) Aggregatemaysatisfyrequirementsofeitheroftwo tests.

(**)

Requirementsofflakinessindexshallbeenforcedonlyincaseofcrushedbrokenstone.

(***)

Aggregateslikebrick,metal,kankar,lateriteetc.,whichgetsoftenedinpresenceof watershall be tested for impact value under wet conditions in accordance with IS: 5640.

Table–5.4:PhysicalRequirementsofCoarseAggregatesforDenseBituminousmacadam(BM)

(AsperTable500-8of MORTH Specification)

Sl.No.	Test	Requirements	TestMethod
1.	LosAngelesAbrasionValue* Or	35percent(max.)	IS:2386(Part–IV)
	AggregateImpactValue*	27percent(max.)	IS:2386(Part–
2.	CombinedFlakinessandElongation Indices (Total) **	35percent(max.)	IS:2386(PartI)
3.	CoatingandStrippingofBitumen Aggregate Mix	Min.Retainedcoating 95%	IS:6241
4.	WaterAbsorption	2percent(max.)	IS:2386(Part-III)
5.	Soundness		
	LosswithSodiumSulphate–5 cycles	12percent(max.)	IS:2386(Part-V)
	LosswithMagnesiumSulphate –5 cycles	18percent(max.)	

(*) Aggregatemaysatisfyrequirementsofeitheroftwo tests

(**) Requirementofflakinessindexshallbeenforcedonlyincaseofcrushedbroken stone

Murum/Kankar/Gravel

Murumshallcontainlowplasticitybindermaterialmixedwithhardgranularparticlessuchassandand/or gravel. Murum shall be sound and hard of a quality not affected by weather, to be screened at the quarry and free from all impurities. Large lumps shall all be broken at the quarry and murum delivered at site must passin everydirection through a 63 mmring. Murumshallnotcontain more than 5%to 8% of fines passing a 75 micron sieve.

Gravelshallbecomposedoflarge,coarse,siliciousgrains,sharpandgrittytothetouch,th
oroughlyfree from dirt, organic and deleterious matter. It shall be hard, tough,
dense and shall not contain particles bigger than 12 mm and more than 10
percent silt.

Sand/StoneDust

The sand / Stone dust shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strengthanddurabilityoftheconcrete,ortoattacktheembeddedsteel.Motorizedsandwashingmachines should be used to remove impurities from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, (Parts I to VIII). The Contractor shall submit to the Engineer the entire informationindicated in Appendix A of IS: 383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5. The Sand used shall be coarse, sharp, gritty, clean, granular material. Only material passing through 4.75 mm sieve and retained on 75 micron sieve shall be used.

Thesand/Stonedust/fineaggregatesshallconformtogradingrequirementin Table 5.5

Table 5.5: Gradation requirement of Sand/ Fine aggregates (As per Table 1000-2 of MORTH Specifications)

IS Sieve Size	Percent by Weight Passing the Sieve		
	Zone I	Zone II	Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79

300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

Note: When the grading falls outside the limits of any particular grading zone of sieves other than 600- micron IS Sieve by a total amount not exceeding 5 percent, it shall be regarded as falling within that gradingzone.Howeverforcrushedstonesand,thepermissiblelimiton150-micronISSieveisincreased to 20 percent. Reference shall be made to clause: 4.3 of IS: 383.

BituminousMaterials

BituminousmaterialsshallconformtoIS:73, IS:215,IS:217orIS:454asapplicableandbeofthegrade specified.

Table5.6:PhysicalrequirementsofCoarseaggregatesforBituminous concrete(BC). (As per TABLE 500-16: MORTH specifications)

PROPERTY	TEST	SPECIFICATION	METHODOF TEST
Cleanliness (dust)	Grainsizeanalysis	Max5%passing 0.075mmsieve.	IS:2386Part I
Particleshape	FlakinessandElongation Index	Max 30% (Combined)2	IS:2386Part I
Strength	LosAnglesAbrasion Value or AggregateImpact Value	Max 30% Max 24%	IS:2386Part IV
Polishing	PolishedStoneValue	Min55	BS:812-114
Durability	Soundness: Sodium	Max 12%	IS:2386PartV

	Sulphate or MagnesiumSulphate	Max 18%	
Water	Waterabsorption	Max 2%	IS:2386Part III

Absorption			
Stripping	CoatingandStripping of Bitumen Aggregate Mixtures	Minimumretained coating 95%.	IS:6241
Water Sensitivity	RetainedTensile Strength*	Min80%	AASHTO283

* If the minimum retained Tensile strength test falls below 80%, use of anti-stripping

agentis recommended to meet the requirement.

Earthwork

EarthworkinExcavation

IngeneraltheexcavationshallbeinaccordancetoSpecificationsspecified elsewhere.

Profilesofroadexcavationshallbelaidat50mintervalsorasspecifiedin Drawingstoconformtothe required alignment, sections, grades and side slopes and the lines of cuts shall be clearly marked.

Contractor shall on no account excavate beyond the slopes or below the specified grade unless so approvedbytheEngineerinwriting.Ifexcavationisdonebelowthespecifiedleveloroutsidethesection the Contractor shall be required to fill up with approved materials, in layers of 150 to 200 mm, watered and compacted as specified for the subgrade.

Theexcavationshallbefinishedneatly,smoothlyandevenlytothecorrectlines, grades, sections as shown in the drawings or approved by Engineer.

EarthworkinSubgrade

TheSubgradeshallbeformedofapprovedsoilexcavatedfromroadtrenchesandstacked separately.

Profilesofsubgradeshallbesetupwithstoutpolestomarkthecentreandedgesoftheformati onwiththe top levels of formation clearly marked by paint or cut and the slopes with strings and pegs at every 10 metres on straight portions.

Subgrade material shall be placed in successive horizontal layers of 200 mm depth extending to the full width of the Subgrade / trench to allow compaction of the full specified section to 150 mm using mini rollers / tampers / plate vibrators tillthesoilis evenlycompactedto95%ofProctor densitywith 2% variation in optimum moisture content. Before placing the next layer of 200 mm the surface of the underlayer shall be moistured and scarified with pick axes or spades to provide a satisfactory bond with thenextlayer.Thenextlayershallalsobecompactedto150mmtothefullwidthofthetrench sectiontill the soil is evenly compacted to 95% of Proctor density with 2% variation in optimum moisture content.

When boulders, broken stones and similar hard materials are mixed up with the embankment materials careshallbetakentoseethat theyaredistributeduniformlyintothebankandthatnohollowsareleft near them. No stone or hard material shall project above the top of any layer. Each layer of embankment shall be watered, levelled, and compacted as specified before the succeedinglayer is placed.The surface of the embankment shall at all times during construction be maintained at such a cross fall as will shed waterand prevent ponding.

If the soil contains less than the optimum moisture, water shall be added to the loose layers of the subgrade to bring the moisture uniformly upto requirement. If the material contains more than the requiredmoistureitshallbeallowedtodryuntilthemoistureisreducedto therequiredextent.The moistured/driedlooselayersshallbecompactedwithavibratoryroller/miniroller/ platevibrator/ tampers to achieve the desired compaction level of 95% of Proctor density.

CompactionwithSand/stonedust

InordertoachievebettercompactionandacompactedsurfacebeforelayingtheGSBlayer,two layersof sand / stone dust shall be laid and compacted to 150 mm each.

Preparationof GranularSub-base (GSB)

Spreading and Compacting: The granular sub base material of **grade-iii** as specified in **Table 5.2: Gradation for coarse graded granular Sub base** (As per Table 400–1 of MORTH Specifications) shallbespreadonthepreparedsubgrademaintainingtherequiredslopeandgradeduringtheoperation or other means as approved by the Engineer or as per applicable MORTH Specifications. The work shall be done as per Clause 401 MORTH V revision and as per BOQ provisions.

Whenthesubbasematerialconsistsofcombinationofmaterialsmentionedinclause401.2,mixingshall be done mechanically by the mix in- place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations,asinsmall –sizedjobs.Theequipmentusedformix-in-placeconstructionshallberotavator or similar approved equipment capable of mixingthematerial tothe desired degree. If so desired bythe Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720 (part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approvedbytheEngineersothat,atthetimeofcompaction,itisfrom1percentaboveto2percentbelow the optimum moisture content corresponding to IS: 2720 (part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS: 2720 (part 8). The surface of any layer of material on completion of compactionshallbewellclosed,freefrommovementundercompactionequipmentandfromcompaction planes, ridges, cracks or loose material.

Allloose,segregatedorotherwisedefectiveareasshallbemadegoodtothefullthicknessoflayerandre – compacted.

WetmixMacadamCourse(WMM)

TheGSBlayersurfaceoverwhichWetmixMacadam(WMM)istobelaidshallbepreparedtothe specified grade and camber and made free of dust and other extraneous material.

Anyruts orsoft yieldingplacesshall be corrected in an approved manner androlled untilfirm. WMM. sub-basecourseofspecifiedthicknessshallbeprovided.Thecourseaggregateforthisshallconformto requirements in **Table-5.7: Grading Requirements of Coarse Aggregates for Wet Mix Macadam (WMM)** (As per Table 400-13 of MORTH Specifications).

Table–

5.7:GradingRequirementsofCoarseAggregatesforWet MixMacadam(WMM) (As per Table 400-13 of MORTH Specifications)

ISSieveDesignation	PercentbyweightpassingtheISsieve
53.00 mm	100
45.00 mm	95 – 100
26.50 mm	-
22.40 mm	60-80
11.20mm	40-60
4.75mm	25-40
2.36mm	15-30
600.00 micron	8-22
75.00 micron	0-8

PreparationofWMMlayer

Preparationofmix:Wet MixMacadamshallbepreparedinanapprovedmixingplant of suitablecapacity having provision for controlled addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

OptimummoistureformixingshallbedeterminedinaccordancewithIS:2720(Part-8)afterreplacingthe aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, waterin the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly uponthe prepared subgrade /sub- base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used so as to achieve the specified slope and grade. The surface of the aggregate shall be carefully checked with templates and all high orlow spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

Compaction: After the mix has been laid to the required thickness, grade and crossfall/camber the same shallbeuniformlycompacted,tothefulldepthwithsuitablevibratoryroller.Thespeedoftherollershall not exceed 5 km/h. The work shall be done as per Clause 406 MORTH V revision and as per BOQ provisions.

Primercoat

Primer: The choice of a bituminous primer shall depend upon the porositycharacteristics ofthe surfaceto be primed as classified in IRC: 16. Surface of low porosity; such as wet mix macadam. The primer shall be bitumen emulsion.

Primer viscosity: The type and viscosity of the primer shall comply with the requirements of IS 8887, as sampled and tested for bituminous primer in accordance with these standards. Guidance on viscosity and rate of spray is given in **Table-5.8: Requirement of Viscosity and quantity of Liquid bituminous Primer** (As per Table 500-1 of MORTH Specifications).

Table-5.8:SelectionCriteriaforViscosity-Graded(VG)PavingBitumensbasedonClimatic conditions(As per Table 500-1 of MORTH Specifications)

LowestDailyMeanAir Temperature, °C	**HighestDailyMeanAirTemperature,°C**		
	Lessthan 20°C	20to30°C	Morethan 30°C
Morethan-10°C	VG-10	VG-20	VG-30
-10°Cor lower	VG-10	VG-10	VG-20

Providing and applying primer coat with S.S. bitumen emulsion on prepared surface of granular base such as WMM including cleaning of road surface and spraying primer at the rate of 0.60 kg/sqm using mechanicalmeanscompleteasperspecificationsTheworkshallbedoneasperClause502MORTHV revision and as per BOQ provisions.

Preparationofroadsurface:Thesurface tobe primed shall beprepared in accordance with Clauses 501.8. and 902 as appropriate. Immediately prior to applying the primer the surface shall be carefully sweptclean of dust and loose particles, care being taken not to disturb the interlocked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

Application of bituminousprimer:The viscosityand rate of application of the primer shall beas specified in the Contract, or as determined by site trials carried out as directed by the Engineer. The bituminous primer shall be sprayed uniformly in accordance with Clause 501 of MORTH specifications. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

Curingofprimerandopeningtotraffic:Aprimedsurfaceshallbeallowedtocureforatleast 24hoursor
suchotherperiodasisfoundtobenecessarytoallowallthevolatilestoevaporatebeforean ysubsequent surfacetreatment or mix islaid. Anyunabsorbedprimer shallfirst beblotted withan applicationof sand, using the minimum quantity possible. The work shall be done as per BOQ provisions.

TackCoat

Over the primed surface, a tack coat should be applied in accordance with Clause 503 of MORTH Specifications.

The binder used for tack coat shall be bitumen emulsion complying with IS 8887 of a type and grade as specified in the Contract or as directed by the Engineer.

The tack coat distributor shall be a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and any extraneous material, and beotherwise preparedinaccordance withtherequirements of Clauses 501.8 and 902 as appropriate. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high pressure air jet, or by other means as directed by the Engineer.

The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly.If rate of application of Tack Coat is not specified in the contract then it shall be at the rate specified in **Table-5.9: Requirement of Viscosity and quantity of Liquid bituminous Tack Coat** (As per Table 500-5 of

MORTH Specifications).

Table-5.9:RequirementofViscosityandquantityofLiquidbituminousTackCoat

(AsperTable500-5ofMORTHSpecifications).

Sl No	Typeof Surface	QuantityofLiquidbituminous material in Kg per sq.m.area
i)	Normalbituminoussurfaces	0.20 to0.30
iii)	Granularsurfacestreatedwithprimer	0.25 to0.30
iv)	Non bituminous surfaces Cementconcretepavement	0.30 to0.35

The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C and for a cutback,50°Cto80°C.TheworkshallbedoneasperClause503MORTHVrevisionandasper BOQ provisions.

BituminousMacadam

The bitumen shall be paving bitumen of Penetration Grade complying with Indian StandardSpecifications for “Paving Bitumen” IS:73.
Aggregate grading and binder content: When tested in accordance with IS: 2386 Part 1 (wet sieving method), the combined aggregate grading for the particular mixture shall fall within the limits shown in **Table-5.10: Composition of Bituminous macadam (BM)** (As per Table 500-7 of MORTH Specification)forthegradingspecifiedinthe Contract.Thetypeandquantityofbitumen, andappropriate thickness, are also indicated for each mixture type.

The aggregates shall be proportioned and blended to produce a uniform mixture complying with the requirements of Table 500-7.

Table-5.10:CompositionofBituminousmacadam(BM) (As per Table 500-7 of MORTH Specification)

Mix designation Nominalaggregatesize Layer	Grading1 40mm	Grading2 19 mm

thickness		
ISSieve(mm)	Cumulative%byweightoftotalaggregatepassing	
45	100	
37.5	90-100	
26.5	75-100	100
19	-	90-100
13.2	35-61	56-88
4.75	13-22	16-36
2.36	4-19	4-19
0.3	2-10	2-10
0.075	0-8	0-8
Bitumen content, % by weightoftotalmixture[1]	3.1 -3.4	3.3 -3.5
Bitumengrade	35 to 90	35 to 90

Preparationofthe Base:

Thebaseonwhichbituminousmacadamistobelaidshallbeprepared,shapedandcompactedto the required profile in accordance with Clause 501.8 and 902.3 as appropriate, or as directed by the Engineer.

PreparationandtransportationoftheMixture:

TheprovisionsofClauses501.3and501.4shallapply.

Spreading: TheprovisionsofClauses501.5.3shall apply.

Compaction:

Compactionshallbecarriedoutinaccordancewiththeprovisionsof Clause 501.6 and 501.7. The details of mixing, laying and rolling temperature of BM mix is as indicated in **Table-5.11:** Mixing, Laying and Rolling Temperatures for Bituminous Mixes (Degree celcius) (As per Table 500-2 of MORTH Specifications)

Rolling shall be continued until the specified density is achieved, or where no density is specified, until thereisnofurthermovementundertheroller. Therequiredfrequencyoftestingisdefinedin Clause 903.

Table-5.11:Mixing,LayingandRollingTemperaturesforBituminousMixes (Degree celcius)
(AsperTable500-2ofMORTHSpecifications)

Bitumen Viscosity grade	Bitumen Temperature (°C)	Aggregate Temperature (°C)	Mixed Material Temperature(°C)	Rolling Temperature (°C)	Laying Temperature (°C)
VG-40	160-170	160-170	160-170	100 Min	150 Min
VG-30	150-165	150-170	150-165	90 Min	140 Min
VG-20	145-165	145-170	145-165	85 Min	135 Min
VG-10	140-160	140-165	140-160	80 Min	130 Min

Thebituminousmacadamshallbecoveredwitheitherthenextpavementcourseorwearingcourse,asthe case may be, within a maximum of forty-eight hours. If there is to be any delay, the course shall be covered by a seal coat to the requirement of Clause 513 before opening to any traffic. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately. The work shall be done as per Clause 504 MORTH V revision and as per BOQ provisions.

BituminousConcrete

Thisworkshallconsistofconstructioninasinglelayerofbituminousconcreteonapreviouslyprepared BituminousMacadam(BM)surface.Theworkshall bedoneasperClause507MORTHVrevisionand as per BOQ provisions.

Bitumen: The bitumen shall be paving bitumen of Penetration grade complying with Indian Standard Specification for Paving Bitumen, IS: 73 and of the penetration indicated in Table500-17, for bituminousconcrete.Thecoarseaggregatesshallbegenerallyasspecifiedin Clause507.2.2,exceptthat the aggregates shall satisfy the physical requirements of Table 500-17.

Requirements for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in **Table-5.12: Composition of BituminousConcrete**(AsperTable500-17ofMORTHSpecifications)and**Table-5.13: Requirement of Bituminous Concrete** (As per Table 500-11: of MORTH Specifications).

Table-5.12:CompositionofBituminousConcrete(AsperTable500-17ofMORTH Specifications)

Grading	**1**	**2**
Nominalaggregatesize	19 mm	13.2 mm
Layer Thickness	50 mm	30-40mm
ISSieve[1](mm)	**Cumulative%byweightoftotal aggregatepassing**	
45		
37.5		
26.5	100	
19	90-100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumencontent %by mass of total mix[2]	Min5.2	Min5.4

Notes:1.

Thecombinedaggregategradingshallnotvaryfromthelowlimitono ne sieve to the high limit on the adjacent sieve.

2. DeterminedbytheMarshallmethod.

3. Jobmixformulashallbegenerallyasspecifiedin Clause507.3.3andthe results of tests enumerated in Table 500-19.

Table-5.13:RequirementofBituminousConcrete (As per Table 500-11: of MORTH Specifications)

Properties	**Viscosity Grade Paving Bitumen**	**ModifiedBitumen**		**TestMethod**
		Hot climate	**Cold climate**	
Compactionlevel	75blowsoneachfaceof specimen			
Minimum stability(kN at 60 °C)	9.0	12.0	10.0	AASHTOT245
Marshallflow (mm)	2-4	2.5-4	3.5-5	AASHTOT245
Marshall Quotient (Stability/Flow)	2-5	2.5-5		MS-2 and ASTMD2041
%Air voids	3-5			
%VoidsFilled with Bitumen (VFB)	65-75			
Coating of aggregateparticle	95% minimum			IS:6241
Tensilestrength ratio	80% minimum			AASHTOT283
%Voidsin Mineral Aggregate (VMA)	Minimumpercentvoidsinmineralaggregate(VMA) areset out in Table 500-12 of MORTH			

Rolling

Immediatelyafterthespreadingofmixitshallbethoroughlycompactedbyrollingwithvibratoryrollers moving at a speed not more than 5 km per hour. Rolling shall be continued till the mix is thoroughly compacted to meet the general provisions of clauses 501.6 and 501.7.

OpeningtoTraffic

Trafficshallbeallowedontheroadafteralapseofminimum24hours,preferably48hoursafterlayingas approved by the Employer’s Representative.

QualityControlofRoadrestorationworks

General

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality controltests,asdescribedhereinafter.Thetestingfrequenciessetfortharethedesirableminimumandthe Engineer shall have the full authority to increase the frequencies of tests as he may deem necessary to satisfy himself that the materials and works comply with the appropriate Specifications.

Test procedures for the various quality control tests are indicated in the respective Sections of these SpecificationsorforcertaintestswithinthisSection.Wherenospecifictestingprocedureismentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the approval of the Engineer.

TestsonEarthworkforEmbankmentandSubgrade Construction

(i) Sandcontent[IS:2720(Part IV)]
1-2testsper8000cu.metresofsoilorasperMORTH.

(ii) PlasticityTest[IS:2720(PartV)]
Eachtypetobetested,1-2testsper8000cu.metresofsoil orasperMORTH.

(iii) DensityTest[[IS:2720(PartVII)].
Eachsoiltypetobetested,1-2testsper8000cubicmetresofsoil orasper MORTH.

(iv) DeleteriousContentTest[IS:2720(PartXXVII)]

AsandwhenrequiredbytheEngineer.

(v) MoistureContentTest[IS:2720(PartII)]

Onetestforevery250cubicmetresofsoilorasperMORTH.

(vi) CBRTestonmaterialstobeincorporatedinthesubgradeonsoaked/ unsoakedsamples [IS:2720 (part XVI)]

Onetestforevery3000m^3atleastorcloserasandwhenrequiredbythe Engineer or as per MORTH.

Compactioncontrol:

Control shall be exercised by taking at least one measurement of density for each 500 square metres of compacted area, or closer as required to yield the minimum number of test results for evaluation a days workonstatisticalbasis.Thedeterminationofdensityshallbeinaccordancewith IS:2720(partXXVIII). Tests locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of testsin one set ofmeasurements shall be 5 aslongasitisfeltthat sufficient control over borrow material and the method of compaction is being exercised. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased to 10.Theacceptanceofworkshallbesubjecttotheconditionthatthemeandrydensityequal sorexceeds the specified density and the standard deviation for any set of results is below 0.08 gm/cc.

However,forearthworkinsubgradeandintop500mmportionoftheembankmentbelow thesubgrade, at least one density measurement shall be taken for every 100 square metres of the compacted area provided further `that the number of tests in each set of measurements shall be at least 10. In other respects, the control shall be similar to that described earlier.

TestsonGranularSubbase(GSB)andWetmixmacadam(WMM) layers

Thetestsandtheirfrequenciesforthedifferenttypesofbasesandsub-baseshallbeasgivenin **Table 5.14**.

Table–

5.14:ControlTestsandtheirfrequenciesforGranularSubbase(GSB)and Wet mix macadam (WMM) layers

Sl.No.	TypesofConstruction	Test	Frequency***
1.	Granularsub-base	i) Gradation ii) Atterbergslimit iii) Moisture content prior to compaction iv) Densityofcompactedlayer v) Deleteriousconstituents vi) C.B.R	Onetestper200 m^3 Onetestper200 m^3 Onetestper250 m^2 Onetestper500 m^2 As required As required
2.	Lime/ CementStabilised	i) Purity of lime (for lime-soil stabilization ii) Lime/Cementcontent iii) Degreeof pulverisation iv) CBRteston asetof 3specimens v) Moisture content prior to compaction vi) Densityofcompactedlayer vii) Deleteriousconstituents	One test for each consignment subject toaminimumofone test per 5 tonnes of lime. Regularly, through procedural checks. Periodicallyas considered necessary. As required Onetestper250 m^3. One test

			per 500 m^2 As required

Sl.No.	TypesofConstruction	Test	Frequency***
3	WetmixMacadam	i) AggregateImpactValue	Onetestper200 m^3 of aggregate
		ii) Grading	Onetestper100 m^3 of aggregate
		iii) FlakinessIndex	Onetestper200 m^3 of aggregate
		iv) Atterberg limits of portion of aggregatepassing425micron sieve	Onetestper100m^3

***OrasperMORTH

TestsonBituminousConstructions

Thetestsandtheirfrequenciesforthedifferenttypesofbituminousworksshallbeasgivenin **Table-5.15** hereunder.

Table–5.15:ControlTestsandtheirFrequencyforBituminousWorks

Sl. No.	Types of Construction	Test	Frequency
1.	PrimeCoat/Tack Coat	i) Qualityofbinder ii) Bindertemperaturefor a application iii) Rateofspreadofbinder	As Required Atregularcloseintervals Twotestsper day

Sl. No.	Types of Construction	Test	Frequency
2	Bituminousmacadam (BM) / Bituminous Concrete (BC)	i) Qualityofbinder	As required
		ii) Aggregate impact value, flakiness index and stripping value of aggregates	Onetestper50-100$m^3$of aggregate
		iii) Mix-grading	One set of test on individual constituents and mixed aggregatesfromthedryerfor each 100 tonnes of mix subjecttoamaximumoftwo sets per plant per day.
		iv) Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling	Atregularcloseinterval.
		v) Stability of mix (vide ASTM:D-1559)	For each 100 tonnes of mix produced, a set of three Marshall specimens to be prepared and tested for stability, flow value density, andvoidcontent,subject toa minimum of two sets being tested per plant per day.
		vi) Binder content and gradation in the mix (Binder contenttest vide ASTM:D-2172)	One test for each 100 tonnes of mix subject to a minimum

		vii) Rate of spread of mixed material	oftwotestsperdayperplant. Regular control through checksontheweightofmixed

Sl. No.	Types of Construction	Test	Frequency
			materialandlayerthickness. Onetestper250m^{2}area

Slab Culvert

Slab culverts shall be constructed at specified locations of the existing cross drainage works as per drawings, or asdirectedbythe Engineer.The Concrete works specificationsfor construction of RC slab andtherubblemasonryspecificationsforthesupportingrubblewallsaregiveninSection-4andSection- 8 respectively and they shall be followed.

BitumenatLocationof Contact

The Bitumen to be used on the top of the bed concrete at the location of contact of RCC slababove in two coats, shall be straight run bitumen of specified grade.

GradedGravelFreeDrainingBackfill

On each side of the uncoursed rubble walls supporting the slab culvert a free draining backfill ofthickness 200 mm shall be provided.The material for this backfill shall be granular consisting of sound, tough,durableparticlesofcrushedoruncrushedgravel,crushedstoneorbrickbatswhich willnotbecome powdery under loads and in contact with water.The material shall be free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances.It shall be graded and shall meet the grading requirements given in Table 5.10 hereunder.

Table5.10

Sieve Designation	**PercentPassingby Weight**
10 mm	100
4.75 mm	30-65
425 microns	5-30
150 microns	0-10

WeepHoles

Weepholes as shown on the drawings or as directed bythe Engineershallbe provided inthe masonryto drainwaterfromthebackfilling.Weepholesshallbeofasbestoscementpipesconformingto IS6908in rubble walls with necessary M10 concrete cushioning, 75 mm thick.They shall extend through the full width of the masonry at a spacing of 1.5 m c/c and with slope of about 1 vertical to 20 horizontal (or as shown on the drawings) towards the draining face.

Pipe Drains

Whereverrequired,pipedrainsshallbeprovidedforcrossdrainagepurposes.Theseque nceof construction shall be as follows:

(a) layingofsand/shinglebeddingontheoriginalground,
(b) layingofPCCofM10 grade,
(c) layingofconcretepipesofNP3classasperIS 458,
(d) Constructingembankmentaboveincompactedmurum,layingofth esub-baseand Wet mix Macadam as specified herein above.

ThedetailsofaboveworksasdirectedbyEngineershallbe followed.

MaterialsforPipeDrains

Allmaterialsusedintheconstructionofpipedrainsshallconformtotherequirementsofth e Specifications.RCC pipes of NP3 class shall conform to IS 458.

Eachconsignmentofcementconcretepipesshallbeinspected,testedifnecessary,andappr ovedby Engineer at the place of manufacture or at site before their incorporation in the Works.

Excavationforpipes

Thefoundationbedforpipedrainshall beexecutedtruetothelinesandgradesshownonthedrawingsor as directed by the Engineer.The pipes shall be placed in shallow excavation of the natural ground in open trenches cut in the existing embankment, taken down to levels as shown in the drawings. Where trenching is involved, its width on either side of pipe shall not be less than 200 mm nor more than one third the diameter of pipe.The sides of the trench shall be as nearly vertical as possible.

When during excavation, the material encountered is soft, spongy or other unstable soil, unless other special construction methods are called for as indicated on drawings, such unsuitable material shall be removed upto a depth of 600 mm or as directed by the Engineer.Before placing any backfill material, exposed surface of the soft soil shall be lightly compacted with one pass of 0.5 T roller.On the lightly

compactedsurface,coarsesandandshingleshallbespreadintwosuccessivelayersof300 mmandeach

layershallbecompactedbyrollingwithamin.0.5Trollerandwithaminimumof 10passeseach,bothin longitudinal and transverse directions.

Whenbedrockorboulderstrataareencountered,excavationshallbetakendownatleast300mmbelow bottom level of pipe as directed by Engineer and space filled with approved sand and shingle and thoroughly compacted to provide adequate support for the pipes.

Trenchesshallbekeptfreefromwateruntilthepipesareinstalledandthejointshavebeenhardened.For this purpose, Contractor shall suggest necessary method for diverting the water.

Beddingforpipe

Thebeddingsurfaceshall provideafirmfoundationofuniformdensitythroughoutthelengthofthepipe drain and shall conform to the specified level and grade.

Thepipeshallbebeddedinacradleofconcretehavingamixnot leanerthanM-10.Thepipesshallbe laid on the concrete bedding before the concrete has set.

Layingof pipes

No pipe shall be placed inpositionuntil the foundations have been approved by Engineer.Whenpipes aretobelaidadjacent toeachother,theyshallbeseparatedbyadistanceatleast equaltoorgreaterthan half the diameter of pipe subject to a minimum of 450 mm.

The laying of pipes on the prepared concrete foundation shall start from the outlet and proceed towards theinletandbecompletedtothespecifiedlinesandgrades.Thepipesshallbefittedandmatchedsothat when laid they form a drain with a smooth uniform invert.

Anypipefounddefectiveordamagedduringlayingshallberemovedatthecostofthe Contractor.

Jointing

All thejointsshall be made with care sothat their interiorface is smooth andconsistent withthe interior surface of the pipes.The ends of the pipes should be so shaped as to form a self-centering joint with jointing space 13 mm wide.The jointing space shall be filled with cement mortar (1 cement to 2 sand) mixedsufficientlydrytoremaininpositionwhenforcedwithatrowelorrammer.Careshal lbetakento fill all voids and excess mortar shall be removed.After finishing, the joints shall be kept covered and damp for at least four days.

Backfilling

Trenchesshallbebackfilledwithselectedmurumasperspecificationsgiveninthispart.Bac kfillingupto
0.3metreabovethetopofpipeshallbecarefullydoneandmurumshallbethoroughly consolidatedunder the haunches of the pipe.

Measurement

Slab Culvert

(a) Measurementofin-situconcreteworkshallbeasspecifiedinSection4ofthis specification.
(b) Measurementofmasonryshallbeasspecifiedin Section8ofthis specification.
(c) Bitumen at locations of contact with concrete surface shall be measured in square metres over area covered in plan and the rates shall include cleaning the surfaces, applying in two coats, etc., as specified.
(d) Graded gravel free draining backfill shall be measured in cubic metres and the rate shall include supplying, backfilling, etc., as specified.
(e) Measurement for weep holes shall be running metres and the rates shall include providing and fixing in rubble masonry walls with necessary concrete cushioning to lines and levels asspecified.

Pipe Drains

Ancillaryworkssuchasexcavation,backfilling,layingP.C.Cbelowpipe,etc.,shallbepaid for separately, as provided under respective clauses.

EndofSection-5

SECTION6

STRUCTURALSTEELWORK

SECTION6

STRUCTURALSTEELWORK

6 ApplicableCodesandSpecifications

The supply, fabrication, erection and painting of structural steel works shall comply with the following specifications, standards and codes unless otherwise specified herein.All standards, specifications and codes ofpractices referred to herein shall be the latest editions including all applicable official amendments and revisions.

1.	IS:808	DimensionsforHotRolledSteel sections
2.	IS:814	CoveredElectrodesforManualMetalArcWeldingofCarbonandCarbon Maganese Steel
3.	IS:800	CodeofPracticeforGeneralConstructioninSteel
4.	IS:801	fPracticeforUseofColdFormedLightGaugeSteelStructural Members in General Building Construction
5.	IS:806	CodeofPracticeforUseofSteelTubesinGeneralBuildingConstruction
6.	IS:7205	SafetyCodeforErectionofStructuralSteel Work
7.	IS:7215	TolerancesforFabricationofSteelStructures
8.	IS:4000	HighStrengthBoltsinSteelStructure –Codeof Practice
9.	AISC	SpecificationsforDesign,FabricationandErectionofBuildings
10.	IS:1161	SteelTubesforstructural purposes
11.	IS:102	Mixedpaint,Brushing,RedLead,Non-setting,Priming.
12.	IS:110	ReadyMixedpaint,brushing,greyfillerforenamelsfor useover primers.
13.	IS:117	ReadyMixedpaint,Brushing,Finishing,ExteriorSemiglossfor generalpurposes, to Indian Standard colours.
14.	IS:158	ReadyMixedpaint,Brushing,Bituminous,Black,Leadfree,Acid,Alkali and heat resisting.
15.	IS:159	ReadyMixedpaint,Brushing,Acidresistingforprotectionagainstacid

		fumes,colouras required.
16.	IS:341	BlackJapan,TypesA,BandC
17.	IS:2339	Aluminiumpaintforgeneralpurposes,inDualcontainer
18.	IS:2932	Specificationforenamel,synthetic,exterior,type1, (a)undercoating,(b)finishing
19.	IS:2933	Specificationforenamel,exterior,type2, (a)undercoating,(b)finishing
20.	IS:5905	SprayedaluminiumandzinccoatingsonIronand Steel.
21.	IS:6005	CodeofpracticeforphosphatingofIronandSteel.
22.	IS:9862	Specificationforreadymixedpaint,brushing,bituminous,black,lead free, acid, alkali, water & chlorine resisting.
23.	IS:13183	Aluminiumpaint,Heatresistant.
24.	SIS-05-5900	(SwedishStandard)
25.	IS:1239	Mildsteeltubes,tubularsandotherWroughtsteelfittings
6.		Part1 –Mildsteel tubes
7.		Part2– Mildsteel tubularsandotherwroughtsteelpipefittings
28.	IS:1363 (Parts1to 3)	HexagonHeadBolts,ScrewsandNutsofproductGradeC(Sizerange M5 to M64)
29.	IS:1367 (Allparts)	TechnicalSupplyConditionsforThreadedFasteners
30.	IS:1852	RollingandCuttingTolerancesforHotRolledSteel Products
31.	IS:1977	StructuralSteel(OrdinaryQuality)
32.	IS:2062	SteelforGeneralStructuralPurposes
33.	IS:2074	ReadyMixedPaint,Airdrying,RedOxideZincChromeand Priming
34.	IS:3502	SteelChequeredPlate

35.	IS:3757	HighStrengthStructuralBolts
36.	IS:5369	GeneralRequirementsforPlainWashersandLockWashers
37.	IS:5372	TaperWashersfor Channels
38.	IS:5374	TaperWasherfor1Beams
39.	IS:6610	HeavyWashersforSteelStructures
40.	IS:8500	StructuralSteel-microalloyed(mediumandhighstrengthqualities)
41.	IS:803	Codeofpracticefordesign,fabricationanderectionofvertical mildsteel cylindrical welded storage tanks
42.	IS:816	CodeofPracticeforuseofMetalArcWeldingforGeneralconstruction in Mild Steel
43.	IS:822	CodeofProcedureforInspectionofWelds
44.	IS:1182	RecommendedPracticeforRadiographicexaminationofFusion – Welded Butt Joints in Steel Plates
45.	IS:1200	MethodofMeasurementinBuildingCivilWorks
46.	IS:1477	CodeofPracticeforPaintingof(Parts1&2)FerrousMetalsinBuildings
47.	IS:2595	CodeofPracticeforRadiographicTesting
48.	IS:3658	CodeofPracticeforLiquidPenetrantFlaw Detection
49.	IS:5334	CodeofPracticeforMagneticParticleFlawDetectionof Welds
50.	IS:9595	RecommendationsforMetalArcWeldingofCarbonandCarbon Manganese Steel
51.	IS:1367	Technical,Supply,Conditionsforsteel(Part13)threadedfasteners
52.	IS:1573	ElectroplatedCoatingofZinconIron and Steel
53.	IS:2629	RecommendedPracticeforHotDipGalvanisingofIronandSteel
54.	IS:2633	Method ofTesting Uniformity ofCoating onZincCoatedArticles
55.	IS:4736	HotDipZinccoatingonMildsteeltubes
56.	IS:4759	HotDipZinccoatingonStructuralSteelandotherAlliedproducts

57.	IS:5905	Sprayed Aluminium andZincCoatingsonIronandSteel
58.	IS:6158	RecommendedPracticeforSafeguardingagainstEmbrittlement ofHotDip Galvanised Iron and Steel
59.	IS:6159	RecommendedPracticeforDesignandpreparationofMaterial Priorto Galvanising
60.	IS:6745	MethodsforDeterminationofWeightofZincCoatingonZinccoatedIron and Steel Articles

SteelMaterials

Steelmaterials shallcomplywith thecodes referred to in Sub-Clause6.1. Allmaterialsusedshallbenew,unusedandfreefromdefects.

SteelconformingtoIS:1977shallbeusedonlyforthefollowing:

Fe310-0(St32-0)	For general purposes such as door/window frames, grills, steel gates,handrails,fenceposts,teebarsandothernon-structuraluse.
Fe410-0(St42-0)	Forstructuresnotsubjectedtodynamicloadingotherthanwind loads such as : Platformroofs,footoverbridges,building,factorysheds etc.
Fe10-0(St42-0)	Gradesteelshallnotbeused a) Ifweldingistobeemployedforfabrication b) Ifsiteisinsevereearthquakezone c) Ifplastictheoryofdesignisused

DrawingspreparedbytheEmployer

Design drawings will be furnished to the Contractor and all drawings so furnished shall form a partofthisspecificationincaseof ItemRateContracts.Thesedesigndrawingsprepared bythe Engineerwillshowallthelevels,forcesonmemberswhereshallnecessary,sizean

dorientation of each member, location/size of openings to enable the Contractor to prepare drawings for fabrication and erection.It shall be clearly understood that these drawings are not intended to show connection details, thickness of members, cuts, notches, bends and such other details.

TheEngineerreservestherighttomakechanges.Revisionstodrawings,evenafterreleasefor preparation of shop drawings, are very likely to be made to reflect additional data/details received and updated requirements.Revisions to drawings and any new drawings made to include additional work by the Contractor shall be considered a part of this specification and contract.The Employer shall not entertain any extra claims on this account.

Where the fabrication drawings are to be furnished by the Engineer, he will issue to the Contractortherequiredcopiesofsuchdrawingsinthesequencerequiredforthefabricationof the components in the order theywill be required to be erected at site.Such drawings will be issued in such numbers as required for the Contractor to adhere to the project schedule.

Should the Contractor during the execution of his work, find discrepancies in the information furnishedbytheEngineer,heshallrefersuchdiscrepanciestotheEngineerbefore proceeding with the work.

DrawingspreparedbytheContractor

The Contractor shall prepare all fabrication and erection drawings for the entire work.All the drawingsfortheentireworkshallbepreparedinmetricunits.Thedrawingsshallpreferablybe of one standard size and the details shown there in shall be clear and legible.

The Contractor shall not commence detailing unless Engineer's design drawings are officially released for preparation of shop drawings.The Contractor shall be responsible for the correctnessofallfabricationdrawings.Fabricationdrawingsshallberevisedbythecontractor toreflectallrevisionsindesigndrawingsasandwhensuchrevisionsaremadebythe Engineer.

AllfabricationdrawingsshallbesubmittedtotheEngineerforapproval. NofabricationdrawingswillbeacceptedforEngineer'sapprovalunlesscheckedandapproved bythe Contractor'squalified structural engineer and accompanied byan erection plan showing the location of all pieces detailed.The Contractor shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections. Fabrication shall be started by the Contractor only after Engineer's approval of fabrication drawings.ApprovalbytheEngineerofanyofthedrawingsshallnotrelievetheContractorfrom the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon.The Engineer's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and

other details.

ThedrawingspreparedbytheContractorandallsubsequentrevisionsetc.shallbe atthecostof the Contractor for which no separate payment will be made.

Fabrication

General

All workmanshipandfinishshall beofthebest qualityandshall conformtothebestapprovedmethodof fabrication.Allmaterialsshallbefinishedstraightandshallbemachined/ groundsmoothtrueandsquare where so specified.All holes andedges shall befree of burrs.Shearingandchippingshall beneatlyand accurately done and all portions of work exposed to view shall be neatly finished.Unless otherwise approved by the Employer’s Representative, reference may be made to relevant IS codes for providing standard fabrication tolerance.Material at the shops shall be kept clean and protected from weather.

Connections

Shop/fieldconnectionsshallbeasperapprovedfabricationdrawings.

Incaseofboltedconnections,taperwashersorflatwashersorspringwashersshallbeused withboltsas necessary.In case of high strength friction grip bolts, hardened washers are used under the nuts or the boltheads whichever areturnedto tightenthebolts.The length ofthe bolt shall be suchthat atleast one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

Inallcaseswherebearingiscritical,theunthreadedportionofboltshallbearonthememb ersassembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

Allconnectionsandsplicesshallbedesignedforfullstrengthofmembersorloads.Column splicesshall be designed for the full tensile strength of the minimum cross section at the splice.

Allbolts,nuts,washers,electrodes,screwsetc.,shallbesupplied/ broughttosite10%inexcessofthe requirement in each category and size.Rates shall cover the cost of this extra quantity.

Allmemberslikelytocollectrainwatershallhavedrainholesprovided.

Straightening

Allmaterialsshallbestraightand,ifnecessary,beforebeingworkedshallbestraightenedand/orflattened by pressure and shall be free from twists.Heating or forging shall not be resorted to without the prior approval of the Employer's Representative in writing.

RollingandForming

Plates,channels,R.S.J.etc.,forcircularbins,bunkers,hoppers,gantrygirders,etc.,shallbeaccurately laidoffandrolledorformedtorequiredprofile/shapeascalledforonthedrawings.Adjacentsections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

HighStrengthFrictionGripBolting

Inspectionaftertighteningofboltsshallbecarriedoutasstipulatedintheappropriatestandardsdepending upon the method of tightening and the type of bolt used.

Welding

Welding procedure shall be submitted to the Employer's Representative for approval.Welding shall be entrustedtoqualifiedandexperiencedwelderswhoshallbetestedperiodicallyandgradedasperIS817, IS : 7310 (Part 1) and IS : 7318 (Part 1).

While fabricating plated beams and built up members, all shop splices in each component part shall be madebeforesuchcomponentpartisweldedtootherpartsofthemembers.Whereverweldreinforcement interferes with proper fit-up between components to be assembled off welding, these welds shall be ground flush prior to assembly.

ApprovaloftheweldingprocedurebytheEmployer'sRepresentativeshallnotrelievetheContractorof his responsibility for correct and sound welding without undue distortion in the finished structure.

Noweldingshallbedonewhenthesurfaceofthemembersiswetnorduringperiodsofhigh wind.

Eachlayerofamultiplelayerweldexceptrootandsurfacesrunsmaybemoderatelypeenedwithlight blows from a blunt tool.Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

Noweldingshallbedoneonbasemetalatatemperaturebelow – 5Deg.C.Basemetalshallbepreheated to the temperature as per relevant IS codes.

Electrodesotherthanlow-hydrogenelectrodesshallnotbepermittedforthicknessesof32mmandabove.

Allweldsshallbeinspectedforflawsbyanyofthemethodsdescribedunder Sub-

clause6.8.3.The choice of the method adopted shall be agreed with the Employer’s Representative.

The correction of defective welds shall be carried out in a manner approved by the Employer’s Representative without damaging the parent metal.When a crack in the weld is removed, magnetic particleinspectionoranyother equallypositivemeansapprovedbytheEmployer’sRepresentativeshall beusedtoensurethat thewholeofthecrackandmaterialupto25mmbeyondeachendofthecrackhas been removed.The cost of all such tests and operations incidental to correction shall be borne by the Contractor.

Tolerances

The dimensional and weight tolerances for rolled shapes shall be in accordance with IS : 1852 for indigenoussteelandequivalentapplicablecodesforimportedsteel.Thetolerancesforfabrication of structural steel shall be as per IS : 7215.

Cutting,punching,drilling,weldingandfabricationtolerancesshallbegenerallyasperrelevantIScodes.

End Milling

Wherecompressionjointsarespecifiedtobedesignedforbearing,thebearing surfacesshallbemilled true and square to ensure proper bearing and alignment.

Inspection

General

The Contractor shall give due notice to the Employer’s Representative in advance of the works being made ready for inspection.All rejected material shall be promptly removed from the shop and replaced withnewmaterialfortheEmployer’sRepresentative’sinspection.Thefactthatcertainmaterialhasbeen accepted at the Contractor’s shop shall not invalidate final rejection at site by the Employer’s Representative if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claimwhich the Employer may make because of defective or unsatisfactory materials and/or workmanship.

NomaterialsshallbepaintedordespatchedtositewithoutinspectionandapprovalbytheEmployer’s Representative unless such inspection is waived in writing by the Employer’s Representative.

TheContractorshallprovideallthetestingandinspectionservicesandfacilitiesforshopworkexcept where otherwise specified.

For fabrication work carried out in the field the same standard of supervision and quality control shall be maintainedasinshopfabricatedwork.Inspectionandtestingshallbeconductedinamannersatisfactory to the Employer’s Representative.

Inspectionandtestsonstructuralsteelmembersshallbeassetforth below.

MaterialTesting

If mill testreports are not available for any steel materialsthesame shall betestedbythe Contractorto theEmployer’sRepresentative’ssatisfactiontodemonstrateconformitywiththerelevantspecification.

Testson Welds

MagneticParticleTest

Whereweldsareexaminedbymagneticparticletesting,suchtestingshallbecarriedoutinaccordance withrelevant IS codes.If heattreatmentis performed, the completed weldshall beexamined afterthe heat treatment.All defects shall be repaired and retested.Magnetic particle tests shall be carried out using alternating current.Direct current may be used with the permission of theEmployer’s Representative.

LiquidPenetrantInspection

InthecaseofweldsexaminedbyLiquidPenetrantInspection,suchtestsshallbecarriedoutin accordance with relevant IS Code.All defects shown shall be repaired and rechecked.

RadiographicInspection

Allfullstrengthbuttweldsshallberadiographedinaccordancewiththerecommendedpractice for radiographic testing as per relevant IS code.

Dimensions,Workmanship&Cleanliness

Membersshall beinspectedat allstagesoffabricationandassemblytoverifythatdimensions,tolerances, alignment,surfacefinishandpaintingareinaccordancewiththerequirementsshownintheContractor's approved fabrication drawings.

TestFailure

Intheeventoffailureofanymembertosatisfyinspectionortestrequirement,theContractorshallnotify theEmployer's Representative.The Contractor must obtain permission from the Employer's Representative before any repair `is undertaken.The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by theEmployer's Representative.

TheEmployer'sRepresentativehastherighttospecifyadditionaltestingashe deemsnecessary,andthe additional cost of such testing shall be borne by the Employer, only in case of successful testing.

TheContractorshallmaintainrecordsofallinspectionandtestingwhichshallbemadeavailabletothe Employer's Representative.

ShopMatching

Forstructureslikebunkers,tanks,etc.Shopassemblyisessential.Forothersteelwork,suchascolumns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc., if so desired by the Employer's Representative.All these shop assemblies shall be carried out by the Contractor.

Markingof Members

After checkingand inspection, all members shall be marked for identification duringerection.This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stampedonit.Theerectionmarkshallbestampedwithametaldyewithfiguresatleast20 mmhighand to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes.
Themarkingshallbesostampedthattheyareeasilydiscerniblewhensortingoutmembers .Thestamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erectionmarksonlikepiecesshallbeinidenticallocations.Membershavinglengthsof7.0 mormore shall have the erection mark at both ends.

Errors

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the Employer's Representativeasdefectiveworkmanship.WheretheEmployer'sRepresentativerejectss uchmaterialor defective workmanship, the same shall be replaced by materials and workmanship conforming to these Employer's Requirements by the Contractor, at no cost to the Employer.

61.

SiteOperations

TheContractorshallcompleteallpreliminaryworksatsitewellbefore thearrivalofstructuralsteel,such as establishment of a well equipped and adequatelystaffedsite office, stores, unloadinggantry, unloading pre-assembly yard, labour quarters ifany,electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc., as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch of steel on site.

The Contractor shall furnish at his own expense, the necessary non-inflammable

staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job.The Contractor shall also provide necessary passageways, fences, safety belts, helmets,lightsandotherfittingstothesatisfactionoftheEmployer’sRepresentativeandto meettherules

oflocalauthoritiesandforprotectiontohismenandmaterials.Alicensedelectricianshallbe keptonthe job for the entire duration of the work to maintain the Contractor's electrical equipment and connections.

The Contractor shall protect all existing plant, structures, piping, conduits, equipment and facilities againstdamageduringerection.Anydamagecausedbycontractorshallberectifiedenti relyathiscost, to the satisfaction of the Employer's Representative.If work has to be carried out adjacent to existing switch yards or electrical installations which are live, the Contractor must ensure suitable safety precautions in consultation with Employer's Representative.

If a portion of the work of the project area cannot be made available to the Contractor for his activities duetooperationsbeingcarriedoutbyotheragencies,heshallsuitablymodifyhissequenc eofoperations so as to continue work without interruption.The Contractor shall work in co-ordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

AcceptanceofSteel,itsHandling& Storage

TheContractorshallcarefullycheckthesteeltobeerectedatthetimeofacceptance.Anyfab rication defects observed should be brought to the notice of the Employer's Representative.

No dragging of steel shall be permitted.All steel shall be stored 300mm above ground on suitable packing to avoid damage.It shall be stored in the order required for erection, with erection marks visible.Allstorageareasshallbepreparedandmaintainedbythe Contractor.Steelshalln otbestoredin the vicinityof areas where excavation or gradingwill be done and, if so stored temporarily, this shall be removed by the Contractor well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer in accordance with these Employer's Requirementsforprotectionafterunloadingandhandlingpriorto erection.Allmilledandmachined surfaces shall be properly protected from rust/corrosion by suitable coating and also from damage.

AnchorBolts&Foundations

TheContractorshallcarefullycheckthelocationandlayoutofanchorboltsembeddedinfoundations constructed, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to the Employer's Representative.

Levelingofcolumnbasestotherequiredelevationmaybedoneeitherbyprovidingshims orthreenuts on the upper threaded portion of the anchor bolt.All shim stock required for keeping the specified thicknessofgroutandinconnectionwitherectionofstructuresonfoundations,cranebracketsoratany other locations shall be of good M.S. plates and shall be supplied by the Contractor at his cost.

Acertainamountofcleaningoffoundationsandpreparingtheareaisconsiderednormalandshallbe carried out by the Contractor at no extra cost.

Wherebeamsbearinpocketsoronwalls,bearingplatesshallbesetandlevelledaspartofthework.All grouting under column base plates or beam bearing plates will be carried out by the Contractor.

Assembly& Connections

Fieldconnectionsmaybeeffected byriveting,bolting,weldingorbyuseofhighstrengthfrictiongrip bolts as shown on the design and erection drawings.

Allfieldconnectionworkshallbecarriedasperthedrawingspreparedbythe Contractor.All bolts,nuts, washers, rivets, electrodes required for field connections shall be supplied by the Contractor.

Allassemblingshallbecarriedonalevelplatform.

Driftsshall beusedonlyfordrawingtheworktoproper positionandmust not beusedtosuchanextent as to damage the holes.Size of drifts larger than the normal diameter of hole shall not be used.Any damaged holes or burrs must be rectified to the satisfaction of the Employer's Representative.

Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall beconsideredasapart oferection.Anyerrorintheshop,whichpreventsproperfit onamoderate amount of reaming and slight chipping or cutting, shall be immediately reported to the

Employer’s Representative.

Erection

All structural steel shall be erected as shown on the drawings prepared by the Contractor.Proper size steel cable slings, etc., shall be used for hoisting.Guys shall not be anchored to existing structures, foundations,etc.,unlesssopermittedbytheEmployer'sRepresentativeinwriting.Cares hallbetakento see that ropes in use are always in good condition.

Steel columnsinthebasement,ifany,aretobeloweredanderectedcarefullywiththehelpofacr ane and/or derrick without damaging the basement walls or floor.

Structural steel frames shallbe erected plumb and true.Frames shall be liftedat points such thattheyare not liable to buckle and deform.Trusses shall be lifted only at node points.In the case of trusses, roof girders, all of the purlins and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals.All steel columns and beams shall be checked for plumb and level individually before and after connections are made.Temporary bracings shall be introducedwhereverneces sarytotakecareofallloadstowhichthestructuremaybesubje cted,including erection equipment and the operation thereof.Such bracings shall be left in place as long as may be required for safety and stability.

Chequered plates shall be fixed to supporting members by tack welding or by countersunk bolts as shown/specified in relevant drawings and/or as approved by the Employer's Representative.The edges shall be made smooth and no burrs or jagged ends shall be left.While splicing, care should be taken so thatthereiscontinuityinpatternbetweenthetwoportions.Careshouldalsobetakentoav oiddistortion of the plate while welding.The erection of chequered plates shall include:

(a) Weldingofstiffeningangles/verticalstiffeningribs
(b) Cutting tosizeandmaking holestorequiredshape whereverne cessary toallow servicepiping and/or cables to pass through
(c) Splicingasshowninrelevant drawings
(d) Smootheningof edges
(e) Fixingofchequeredplatesbytackweldingorbycountersunkbolts
(f) Providingliftinghooksforeaseoflifting.

Aserectionprogresses,theworkshallbesecurelyboltedtotakecareofalldeadload,wind,se ismicand erection stresses.

No riveting or welding or final bolting shall be done until the structure has been properly aligned and approvedbytheEmployer'sRepresentative.Nocutting,heatingorenlargingoftheholes shallbecarried out without the prior written approval of the Employer's Representative.

Testcertificatesshallbefurnishedbythe Contractor.

Inspection

The Employer's Representative shall have free access to all parts of the job during erection and all erection shall be subjected to his approval.In case of faulty erection, all dismantling and re-erection requiredwillbeattheContractor'scost.Nopaintshallbeappliedtorivetheadsorfieldwel dsorbolts until these have been approved by the Employer's Representative.

Tolerances

General

Tolerancesmentionedbelowshallbeachieved aftertheentirestructureorpartthereofisinline,leveland plumb.

Columns

Deviationofcolumnaxesatfoundationtoplevelwithrespecttotrue axes:

(a) Inlongitudinal direction	±5 mm
(b) Inlateral direction	±5 mm

Deviationinthe level of bearing surfaceofcolumnsatfoundatio n topwithrespecttotruelevel	±5mm

Outofplumbness(verticality)ofcolumnaxisfromtrueverticalaxis,asmeasuredatcolumnt
op:

(a) For columns upto and including

±1/1000ofcolumnheightinmm 15 metres in height or ±15 mm whichever is less

(b) For columns exceeding 15

±1/1000ofcolumnheightinmm metres in height or ±20 mm whichever is less

Deviation in straightness in longitudinal

±1/1000ofcolumnheightinmm and transverse planes of column at any or ±10 mm whichever is less point along the height

Difference in erected position of adjacent

±10mm pairs of columns along length or across width of building prior to connecting trusses/beamswithrespecttotruedi stance

Deviation in any bearing or seating level

±5mm with respect to true level

Deviation in differences in bearing level

±10mm of a member on adjacent pair of columns

bothacrossandalongthebuilding

Trussesand Beams

Shift at the centre of span of top chord

±1/250ofheightoftrussinmm member with respect to the vertical plane or ±15 mm whichever is less passing through the centre of bottom chord

Lateralshiftoftopchordoftrussat the centre of span from the vertical plane	±1/1500ofspanoftrussinmm
or±15mmwhicheverisless passing through the centre of supports ofthetruss	
Lateral shift in location of truss from its	
±10mm true vertical position	
Lateral shift in location of purlin true	
±5mm position	
Deviationindifferenceofbearing levelsoftrussesorbeamsfrom the true difference	i)±20mmfortrusses ii)Forbeams: Depth < 1800mm : ±6mm Depth>1800mm: ±10mm
Deviation in sag in chords and diagonals	1/1500 of length in
mm or of truss between node points	
10mmwhicheverissmaller	
Deviation in sweep of trusses, beams etc.	
1/1000ofspaninmmsubject in the horizontal plane to a maximum of 10 mm	

CraneGirders&Rails

Shift in the centre line of crane rail with

±5mm respect to centre line of web of crane

girder

Shift in plan of alignment of crane rail with

±5mm respect to true axis of crane rail at any

point

Difference in alignment of crane rail in plan

±1mm measured between any two points 2

metres

apartalong rail

Deviationincranetrackwithresp

ectto Time gauge

(a) Fortrackgaugesuptoand Including15metres	±5 mm
(b) Fortrackgaugesmorethan 15 metres	±[5+0.25(S-15)] whereSinmetresistruegauge
Deviationinthecraneraillevelatany pointfromtruelevel	±1/1200ofthegaugedistanceor ±10mmwhicheverisless

Difference in the crane rail actual levels

±2mm between any two points 2 metres apart

alongtherail length

Differenceinlevelsbetweencranetr

ack Rails at

(a)	Supportsofcrane girders	±15 mm
(b)	Midspanofcranegirders	±20 mm

Relativeshiftofcranerailsurfacesata jointinplaneandelevation	2mmsubjecttogrindingof surfacesforsmoothtransition

Relative shift in the location of crane

1/1000oftrackgaugeSin stops (end buffers) along the crane tracks

mm subject to

maximum with track gauge S in mm of20 mm

CleanupofWorkSite

During erection, the Contractor shall at all times keep the working and storage areas used by him free from accumulation of waste materials or rubbish.Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to the Employer’s Representative.

Painting

General

62. After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt headsandnutsshallbespotpaintedwithprimer.Beforepaintisapplied,thesurfaceshallbedry and free from dust, dirt, scale and grease.All surfaces inaccessible after erection shall receive two coats of the approved paint beforeerection.

Surface Treatment

Allthesurfacesofsteelworktobepaintedshallbethoroughlycleanedofallloosemillscale,rust,grease, dirt and other foreign matter. The workmanship shall generally conform to the requirements of IS 1477- Part I.

Oil and grease removal shall be carried out either by solvent cleaning or by using alkali type degreasing agents. To remove grease material the surface shall be cleaned with solvents containing emulsifier. After cleaning,thesurfaceshallbewashedwithwater.Whenthesurfacehascementpelterorsalts,thecleaning shall be done with strong alkalies. After cleaning, water rinsing and subsequent passivation by dilute chromic acid rinsing shall be carried outto ensure that no traces of alkali is left on the surface. The procedure for cleaning by above mentioned methods shall be as per manufacturer's instructions.

Derustinganddescalingofsteelshallbecarriedouteithermanually,mechanicallyorchemically.

ManualorHandTool Cleaning

Loose mill scale, loose rust and loose paint shall be removed by wire brushing, scrapping, chipping, rubbingwithabrasivepaperorsteelwool.Thismethodshallnotbeemployedwhenthesurfacehasfirmly adhering mill scale. After hand tool cleaning, the surface shall be rubbed with sand paper so as to ensure that no loose material exists and the surfaces shall be dusted off.

MechanicalCleaning

PowerToolCleaning:

This shall be carried out by employing power operated wire brushes. Power tool cleaning shall be resorted to only if sand/shot blasting is not possible/permissible and high quality of surface preparation is required.

Thesurfacepriortotreatmentshallhavebeencleanedofdustandgreaseandheavierlayersofrust removed by chipping.

Thepowertoolcleaningshallremoveloosemillscaleandrustbyadoptingverythoroughscrapping, grinding and machine brushing. After the surfaces are cleaned by compressed air, it shall have a pronounced metallic sheen.

Flame Cleaning:

Hard millscale and rustshall be removed through Oxy-acetyleneflame.The workshall becarried out by trainedworkmentoensurethatonlymillscaleisremovedwithoutheatingtheparentsteel. Theworkshall be carried out carefully on welded surfaces so that the strength of weld is not affected due to heating.

SandBlastingandShot Blasting

Sand/ shotblastingshallonlybecarriedoutafterremovalofgrease,oilandothercontaminants.T hework shall be carried out byimpingingunder pressure of air,a jet of sharp sand or granulated steel (steel grits) ontothemetal surface.Theprocessshall ensurecompleteremoval ofrustandfirmlyadheringmill scale. Specialcare shall betakenon weldareasto remove flux and spatter. Blastingshallensure aneven colour of the surface and the surface shall have silver grey colour. Precautions shall be taken when sand or shot blasting of light gauge steel surfaces to ensure that buckling does not occur due to continuous impingement of sand or steel shots under high velocity.

Sand/shot blasting shall be adopted for structures which are exposed to corrosive conditions for which superiorpaintprotectionistobeadopted.Thefinishedsurfacesshallconformtotherequire mentsofSa 2.5orSa3asperSwedishStandardSIS-05-5900asrequired.

Assandblastingcausesdustnuisance,necessaryclearanceshallbeobtainedbytheContrac torfromthe Competent authorities prior to commencing sand blasting.

ChemicalCleaning(Pickling)

Thecleaningshallbedonebypicklinginsulphuric,hydrochloricorphosphoricacids.Picklin gshallbe carried out in accordance with detailed procedure as given in IS 6005.

Washingafterpicklingshallremovealltracesoftheacids.Allworkpiecesshallbethoroughl yinspected and in particular the inaccessible corners.

Allsurfacesshallbecleanedthoroughlyaspermanufacturer’sspecificationbeforeapplicat

ionofprimer.

Materials

PrimerPaint

Anti-corrosiveprimersshallbeeitherleadbasedorleadfreetypes.Redleadprimer shallconformtoIS 102 and red oxide zinc chrome primer shall conform to IS 2074.

FinishPaint

Epoxyprimerandepoxypaintshallbeofthetypeasspecifiedfromanapproved manufacturer.

Chlorinatedrubberbasedpaintshallbeofthemanufactureasspecifiedoranyequivalentap proved manufacture.

Allthematerialsshallbeofthebestqualityfromanapprovedmanufacturer.TheContract orshallobtain priorapprovaloftheEmployer'sRepresentativeforthebrandofmanufactureandthecol our/shadeprior to procurement for usage in the works.

Primerandfinishpaintsshallbecompatiblewitheachothertoavoidcrackingandwrinkling. Assuchitis recommended that the primer and finish paint shall be from the same manufacturer.

The colour and shade shall be conforming to IS Standards referred to in Appendix 'D' of IS 1477-Part II. Tofacilitatechoosingthecorrectshadenumberfromthealternativesavailable,theContr actorshalladopt trial painting in small patches in consultation with and as approved by the Employer's Representative.

All paint delivered to the fabrication shop/site shall be ready mixed, in original sealed containers, as packedbythemanufacturer.Thinnershallnotbepermittedforusageunlessspecificallya pproved soby the Employer's Representative.

Paintsshallbestirredthoroughlytokeepthepigmentinsuspension.

The Contractor shall arrange for testing of paints as per relevant Indian Standards in an approved laboratorywhenevertheEmployer'sRepresentativerequiresthetesttobecarriedoutfo reachbatchof paints. Test results shall be submitted to the Employer's Representative for approval.

Workmanship

Thetypeandthenumberofcoatsoftheprimerpaintandfinishpaintshallbeass

pecified. Painting shall be carried out only on thoroughly dry surfaces.

No painting shall be done in frosty/foggy weather or when the humidity is high enough to cause condensationonthesurfacetobepainted.Paintshallnotbeappliedwhenthetemperature ofthesurface to be painted is at 5deg.C or lower.

Primers shall adhere to the surface firmly and offer a key to the subsequent coats.

Workmanshipshallgenerallyconformtorequirementsspecifiedin IS:1477-PartII.

It is essential to ensure that immediately after preparation of the surfaces, the first coat of primer paint shallbeappliedbybrushingandworkingitwelltoensureacontinuousfilm.Afterthefirstcoatbecomes hard dry a second coat of primer shall be applied by brushing.

Structural steel surfaces shall be given the first coat of primer at shop and the second coat after it is erectedinposition.Further,anyabradedsurfacesofthefirst coat duringtransportfromshoptositeand during erection shall be provided with a touch-up coat of the primer.

Thedryfilmthicknessofeachcoatofprimershallbenotlessthan25microns.

Applicationoffinishingpaintsshallbecarriedoutwithintheshortestpossibletimeintervalafterprimer since the primer coats are too thin to give adequate corrosion protection of the steel surface over a long duration.

Filler coats shall be applied to fill dents and to obtain a smooth finish wherever necessary. Only factory prepared filler suitable for steel work shall be used. Fillers prepared by whiting and linseed oil by craftsmen at site shall not be used.Application of filler shall be done with good `putty knife' and necessary skill. Filler applied shall be just sufficient to fill the depression or unevenness and it shall be restricted to the minimum. It shall be applied in thinlayers. In fillingdepression or unevenness, as many coats as are necessary may be applied allowing each layer to dry hard. The hardened coat shall be cut downbywetrubbingbeforethesubsequentcoatisapplied.Wherenecessary,fillercoatsshallbeapplied over the undercoats also.

Paintingshallbecarriedouteitherbybrushingorbyspraying.TheContractorshallprocurethe appropriate quality of paint for this purpose as recommended by the manufacturer.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface.When the surface becomes dry, the undercoat of paint of optimum thicknessshallbeappliedbybrushing/sprayingwithminimumofbrushmarks.The coatshallbe allowed to hard-dry.The under coat shall then be wet rubbed cutting down to a smooth finish, takingadequatecareto ensurethat at no placetheundercoat is completelyremoved.Thesurface shall then be allowed to dry.

The first finishing coatof paint shall be applied by brushing or by spraying and allowed to hard-dry.The gloss from the entire surface shall then be gently removed and the surface dusted off.The second finishing coat shall then be applied by brushing or by spraying.

At least 24 hoursshall elapsebetween the applications ofsuccessivecoats.Each coat shall varyslightly inshadeand shallbeapprovedbythe Employer'sRepresentative,priorto applyingthe next coat.

Minimum dry film thickness of each coat of finish paint of synthetic enamel shall be 25 microns. Minimumdryfilmthicknessof otherfinishpaintsshallbeasspecifiedintherespectiveitemofwork.

ThethicknessoffilmshallbemeasuredbyanElcometer tobesuppliedbytheContractor.The ContractorshallcalibratetheElcometerfrequentlyfordifferentsettings.Neces sarycalibrating accessories should be kept ready for calibration / testing of the Elcometer at any time.

Epoxyprimerandepoxypaintshallbeappliedwithinthespecifiedpotlifeallasperrecomm endationsof the manufacturer.

Surfacesinaccessibleafterassemblyshallreceivetwocoatsofprimerpriortoassembly.

Surfaces inaccessible after erection, including top surfaces of floor beams, supporting grating or chequeredplateshallreceiveoneadditionalcoatoffinishpaintoverandabovethenumber ofcoats specified prior to erection.

Portion of steel members embedded/to be encased in concrete shall not be painted.Joints to be site welded shall have no shop paint for atleast 50mm from the welding zone.Similarly, the steel surfaces shall not bepaintedinareaswhereconnectionisbyuseoffrictiongripbolts.Oncompletionofthejoi nt, the surfaces shall received the painting as specified.

Maintenancepaintingofsteelstructureswillbecomenecessaryifthepaintingalreadycar riedoutshows signs of chalking, hairline cracking, deep checking, fine checking, peeling, blistering and rusting.It is essential that same quality of paint as specified earlier need be adopted to ensure compatibility.The general workmanship for maintenance painting shall conform as per Clause.7 of IS 1477 – Part II.

TheContractorshallprovidesuitableprotectionasnecessarytopreventpaintfinishesfrom splashingon equipment, floors, walls, etc.

MethodofMeasurement

63. For the purpose of payment, the weight of the actual, completed structures shall be calculatedfromtheapproveddrawingsfordifferentitemsofwork.Contractors hallsubmitto Employer relevant material list containing weight of each item.
64.
65. No allowance will be permitted for weights of rivets, bolts, washers, screws etc. in calculating the weight of the completed structure.No allowances will be permitted for galvanizing,weldingorforrollingmargins.Onetonneforthepurposeofpaymen tshallmean One Metric Tonne i.e. 1000 kg.
66.
67. The weight of a member made out of standard rolled sections such as beams, channels, angles, etc. shall be based on the weight of the member given in IS 808, without deducting for hole, notches, bevel cuts, etc.Where a component consists of a cut joist or channel, the full weightoftherolledsectionshallbeconsideredonlyifmorethanhalfthedepthofth esectionis used.Otherwise only half the section unit weight shall be taken.Deductions shall be made in the weight of gussets/plates including chequered plates for skew cuts, notches and openings of 900 sq.cm. or larger.
68.
69. Forgussets/ platesusedintrusses,bracings,columns,beamsetc.theareashallbethatof the minimum circumscribing rectangle, except as stated above.
70.
71. Theweightofanybuilt-upmembershallbeseparatedintotheweightofeachcomponent. 72.
73. Erection bolts installed by erector may be left in position on completion of erection; however, no additional payment shall bemade either for supplyor useof such bolts.If erection boltsareremovedaftererectioniscomplete,holesshallbeplugweldedandgroun dsmooth.No extra payment shall be made for such plug welding.
74.
75. Painting work shall not be measured separately, if primer painting and/or primer and finish painting is deemed to be included in the scope of the item of work of fabrication and erectionofstructuralsteelsincetheratepertonneofsteelisdeemedtoincludefo rpaintingas specified.
76.
77. In cases where primer and/or finish painting work as specified is

carried out on erected structural steel executed bya different agency, the method of measurement for painting shall be onthebasisoftonnageofsteelerected.Forthispurpose,thetonnageoferectedsteelascertified forpayment to the different agencyshall be considered as the basis and no measurement will be carried out separately.

GalvanisingofStructuralSteel
GalvanisingPlant

PriorapprovalshallbeobtainedfromEmployer/
Engineerifgalvanisingisproposedtobecarriedoutoutside Contractor's plant.

Workmanship

Afterallshopworkiscomplete,allstructuralmaterialsshallbepunchedwiththeerectionmarkandbehot-
dipgalvanised.Beforegalvanising,thesteelshallbethoroughlycleanedofanypaint,grease,rust,acidor
alkaliorsuchotherforeignmattersasarelikelytointerferewiththegalvanisingprocessorwiththequality
anddurabilityofthezinccoating.Picklingshallbeverycarefullydoneandshallbeproper.

Theweightofthezinccoatingshallbeatleast0.610kg/
sq.munlessspecifiedotherwise.Stubmembersand
membersforgrillagetypefootingshallhaveheavierzinccoatingnotlessthan0.80kg/sq.m.

Thegalvanisedsurfaceshallconsistofacontinuousanduniformlythickcoatingofzinc,firmlyadheringto
thesurfaceofsteel.Thefinishedsurfaceshallbecleanandsmooth,andshallbefreefromdefectslike
discolouredpatches,barespots,unevennessofcoating,spelterwhichislooselyattachedtothesteel,globules, spiky de S:2633 unless specified otherwise.

AllgalvanisedmembersshallbetreatedwithSodiumdichromatesolutionoranapprovedequivalentafter galvanising, soasto preventwhitestoragestains.

Galvanisingofeachmembershallbecarriedoutinonecompleteimmersion.Doubledippingshallnotbe
permitted.However,incaseofmembersover7.5Mlong,theContractorshalltakepriorapprovalof
Engineerfordoubledipping.Whenthesteelsectionisremovedfromthegalvanisingkettle,
excessspelter shall be removed by 'bumping'.

Wherevergalvanisedbolts,nutslocknuts,washers,accessoriesetc.arespecified,theyshal

lbehot-dip galvanised.Springwashersshallbeelectro-
galvanised.Excessspelterfrombolts,nuts,etc.shallberemoved
bycentrifugalspinning.Rechasingofboltthreadsaftergalvanisingshallnotbepermitted.
Nuts,however,
maybetapped,butnottocauseappreciablerockingofthenutsonthebolts.Readilyavailable
GInuts,bolts andwashersconformingtogalvanisingrequirementsmayalsobeused.

Defectsincertainmembersindicatingpresenceofimpuritiesinthegalvanisingbathinquantitieslargerthan
thatpermittedbythespecifications,orlackofqualitycontrolinanymannerinthegalvanisingplant,shall rendertheentireproductionintherelevantshiftliabletorejection.

Contractorshallensurethatgalvanisingisnotdamagedintransit.Intheeventofoccurrenceofanydamages
Contractorshallathisowncostadoptscrappingandregalvanisingthemembertosatisfythespecific requirements.

EndofSection-6

SECTION 7

WATERSUPPLYANDSANITARYWORKS

SECTION7

WATERSUPPLYANDSANITARY WORKS

ApplicableCodes

Thefollowingstandardsandcodesaremadeapartofthis Employer’sRequirement.Allstandards,codes of practice referred to herein shall be the latest editions including all official amendments and revisions.

IS:210	:	Specificationforgreyironcastings
IS:269	:	SpecificationforOrdinaryPortlandcement
IS:383	:	Specificationforcoarseandfineaggregatesfromnaturalsources for concrete
IS:432	:	Specificationformildsteelandmediumtensilesteelbarsand hard drawn steel wire for concrete reinforcement
IS:456	:	CodeofPracticeforplainandreinforced concrete
IS:458	:	ConcretePipes(withandwithoutreinforcement).
IS:516	:	Methodsoftestsforstrengthofconcrete
IS:554	:	Dimensionsforpipethreadswherepressuretightjointsarerequiredon the threads.
IS:651	:	Saltglazedstonewarepipesand fittings.
IS:774	:	FlushingCisternsforwaterclosetsandurinals(valvelesssiphonictype)
IS:775	:	Castironbracketsandsupportsforwashbasinsand sinks.
IS: 781	:	Sand-castbrassscrew-downbibtapsandstoptapsforwater services.
IS:783	:	Codeofpracticeforlayingofconcretepipes.
IS:1068	:	Electroplatedcoatingsofnickelandchromiumofironand steel.
IS:1077	:	Specificationforcommonburntclaybuildingbricks

IS:1786	:	Specificationforhighstrengthdeformedsteelbarsandwires for concrete reinforcement
IS:1239	:	Mildsteeltubes(PartI)andmildsteeltubularsandotherwrought steel pipe fittings (Part II)
IS:1536	:	Centrifugallycast(spun)ironpressurepipesforwater,gasandsewage.
IS:1626	:	Asbestoscementbuildingpipes,guttersandfittings(spigotandsocket types).
IS:1703	:	CopperAlloyfloatvalves(horizontalplungertype)forwatersupply purposes.
IS:1726	:	Castironmanholecoversand frames.
IS:1729	:	Sandcastironspigotandsocketsoil,wasteandventilatingpipes,fittings and accessories.
IS:1742	:	Codeofpracticeforbuildingsdrainage
IS:2116	:	Specificationforsandformasonrymortars
IS:2212	:	Codeofpracticeforbrickwork
IS:2250	:	Codeofpracticeforpreparationanduseofmasonrymortars
IS:2326	:	Automaticflushingcisternsforurinals
IS:2470	:	Codeofpracticefordesignandconstructionofseptic tanks(PartsI&II)
IS:2556	:	Vitreoussanitaryappliances(PartItoPartXV)
IS:2963	:	Specificationforcopperalloywastefittingsforwashbasinsand sinks
IS:3006	:	Specificationforchemicallyresistantglazedstonewarepipes andfittings
IS:3311	:	Wasteplunditsaccessoriesforsinksandwashbasins
IS:5455	:	Specificationforcastironstepsfor manholes
IS:4127	:	CodeofPracticeforlayingofglazedstonewarepipes
IS:3495	:	Methodsoftestsofburntclaybuildingbricks
IS:4111	:	Codeofpracticeforancillarystructuresinseweragesystemmanholes

IS:5382	:	Specificationforrubbersealingringsforgasmains,waterm ainsand sewers
IS:5329	:	Codeofpracticeforsanitarypipeworkabovegroundfor buildings
IS:5434	:	Non-ferrousalloybottletrapsformarineuse
		IS:4985:SpecificationsforUnplasticizedPVCpipesforpota ble water supplies
		IS:7634:CodeofPracticeforPlasticpipesselection,Handlin g, storage and installation for Potable water supplies
		IS:13592:SpecificationsforUnplasticizedPolyvinylchlori depipes for soil and waste discharge system for inside and outside buildings injcludingventilationandrainwatersystem

SanitaryInstallation

Theworkshallbecarriedoutcomplyinginallrespectswithanyspecificrequirementsoft helocalbody in whose jurisdiction the work is situated, and as approved by the Employer’s Representative.

Anydamagecausedtothebuilding,ortoinstallationstherein,eitherduetonegligenceonth epartofthe Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.

Allsanitaryandplumbingworkshallbecarriedoutbylicensed plumbers.

Allsanitaryappliancesincludingsanitaryfittings,fixtures,toiletrequisitesshallbeofsize,a nddesignas approved by the Employer’s Representative.

Allwhiteglazedporcelainfixtures,such aswashbasin,sinkdrainboard,waterclosetpan,urinal,`P'trap etc.shall have harddurablewhite glazedfinish.Theyshall befree fromcracks and other glazingdefects. No chipped porcelain fixtures shall be used.

Jointsbetweenironandearthenwarepipesshallbemadeperfectlyairandwatertightbyca ulkingwith neat cement mortar.

IndianTypeWaterCloset

This shall be the long pan pattern with separate footrests made of white glazed earthenware; white glazed vitreous china or of white glazed fire clay. The general requirements shall conform to IS:2556 (Parts III and X). Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush type. The flushing rim and inlet shall be of the self draining type. It shall have a weephole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise approved by the Employer’s Representative. The inside of the bottom of pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth enable easy and quick disposal while flushing. The exterior surface shall be unglazed and sufficiently rough or grooved at right angles to the axis of the outlet. Pans shall be provided with a trap `P' or `S' type with a minimum 50 mm water seal and 50 mm dia. vent horn. Pan shall be laid at the correct location and level over a bed of lime concrete using brick aggregates (1 part lime mortar to 2 parts brick bats with lime mortar to 2 parts of sand) or cement-sand admixture as specified in the drawings.

EuropeanTypeWaterCloset

Waterclosets shall be either ofwhite glazed earthenware, whitegrazed vitreouschina or whiteglazed fire clay as specified and shall be of "Siphonic Wash down type" conforming to IS.2556 (Part VIII). The closets shall be of one piece construction with approved plastic/bakelite seat and cover. Each water closet shall have 4 fixing holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The water closet shall have a weephole at theflushinginlet.Eachwater closet shall have anintegral trapwith either "S" or "P"outlet with at least 50 mm water seal. The water closets shall have an antisiphonage 50 mm dia. vent horn on the outlet side of the trap. The inside of water closets and traps shall be uniform and smooth in order to ensure in efficient flush.The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the water closet installed.

Urinals

Urinals shall be of the bowl pattern, either flat back or angle back type lipped in front. They shall be of white glazed earthenware, white glazed vitreous

china or white glazed fire clay, and of size as specified conforming to IS.2556 (Part VI). The urinals shall be of one piece construction. Each urinal shall be provided with not less than two fixings holes of a minimum dia. of 6.5 mm on each side. Each urinal shall have an integral flushing box rim of suitable type and inlet or supply hornfor connectingtheflushpipe.The flushing rimandinletshallbeoftheself-drainingtype.It

shall have a weephole at the flushing inlet of the urinal. At the bottom of the urinal, an outlethorn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall notbe glazed and the surface shall be provided with grooves at right angles to the axis of the outletto facilitate fixingto the uniform and smooth throughout to ensure efficient flushing. Thebottom of pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. The waste fittings shall be chromium plated.

WashBasins

Wash basins shall be of white glazedearthenware,white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative and conforming to IS.2556

Type	Size
FlatBack	630x450mm
FlatBack	550x400mm

Wash basins shall be of one piece construction, including a combined overflow. All internal angles shall be designed soas to facilitate cleaning. Each shall have a rimslopinginside towards the bowl on all sides except skirting at the back. Basins shall be provided with single or double tap holes as approved. The tap holes shall be square. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have a circular waste hole to which the interior of basin shall drain.The waste holeshall beeither rebated or bevelledinternallywith diameter of65 mmat top and a depthof 10 mmto suita waste plughaving64 mm diameter. Each basinshall be provided with a non-ferrous 32 mm waste fittings. Stud slots to receive the brackets on the under side of the wash basinsshallbesuitableforabracketwithstudnotexceeding13mmdiameter,5mmhigh and305mm fromthebackofbasintothecentreofthestud.Thestudslotsshall beofdepthsufficient totake5mm stud. Every basin shall have an integral soap holder recess or recesses which shall fully drain into the bowl. The position of the chain stay-hole shall not be lower than the overflow slot. A slot type of overflow having an area of not less than 5 sq.cm. shall be provided and shall be so designed as to facilitate cleaning of the overflow. The Employer's Requirements for waste plug, chain and stay shall be the same as given for sinks.

Allthewastefittingsshallbechromiumplated.Bottletrapshallconformto IS.5434.ThechromiumplatingshallbeofservicegradeNo.2conforming to

IS.1068.

Sinks

The sinks shall be of white glazed earthenware, white glazed vitreous china or whiteglazed fire clay as approved by the Employer's Representative conforming to IS.2556 (Part V) and shall be of the following sizes:

450 x 300x 150 mm

600 x 450x 200 mm

They shall be of one piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outletshall in all cases be suitable for waste fittings having flange of 64 mmdiameter and the waste hole shall have a minimum diameter of 65 mm at the bottomto suit the waste fittings. The waste hole shall be either rebated or bevelled having a depth of 10 mm. Each sink shall be provided with a non-ferrous 40 mm dia. waste fitting. The sink shall have overflow of the weirtype and the inverts shall be 30 mm below the top edge. Each sink shall be provided with a waste plug, of suitable dia. chain and stay. The plug shall be of rubber or other equally suitable material and shall be water tightwhen fitted. Plug chains shall be of brass wire chromium plated. It shall have an overall length from the collar to the stay of not lessthan 300 mm. There shall be a triangular or D shackle at each end, one of which shall be brazed to the plug and theother securely fixed to thestay. The 150 mm long shank of the waste shall be threaded conforming to the requirements of IS.2556 for sinks only. The waste fittings and plug fittings shall be chromium plated. The chromium plating shall be of service grade No.2 conforming to IS.1068.

Flushing Cisterns

The flushing cisterns shall be automatic or manually operated, high level or low level, as approved by the Employer's Representative. For water closets and urinals high level cistern is intended to operate with minimum height of 125 cm and a low levelcistern a maximum height of 30 cm between the top of thepan and the underside of the cistern. They shall be of cast iron, glazed earthenware, or pressed steel complying iron, glazed requirement of IS.774. Automatic flushing cistern for urinals shall conform to IS.2326.

UnplasticisedPVCpipesandfittings:

UnplastiscisedpolyvinylChloridePipeforSoilandWasteDischargeSystemforInsideandOutside Buildings Including Ventilation and Rain Water System IS 13592 andIS 14735 Specification

UPVCInjectionMouldedFittingsforSoilandWasteDischarge.

Unplasticisedpolyvinylchloridepipes,fittingsandspecialsshallbetoBS3505forportablewaterand BS 4346: Part 1for fitting.

Thepipeshallbeofthespiogotandsockettypewithapprovedgaskettypeflexiblejoint.The rubber gasket shall be to BS 2494, Class C.

IS7634Plasticpipeselection,handlingstorageandinstallationforportablewatersupply.

WherePVCpipes,fittingsandspecificationsaretobeconnectedtocast iron,stainlesssteel orsteelpipes, all metallic pipes, Viking Johnson type flange adopted or stepped coupling shall be used.

Stonewarepipesandfittings

All pipes with spigot and socket ends shall conform to IS.651/3006 and shallbeofgrade `A'. These shallbesound,freefromvisibledefectssuchasfinecracksorhaircracks.Theglazeofthepipesshallbe free from crazing. The pipes shall give a sharp clear note when struck with a light hammer.

Thefollowinginformationshallbeclearlymarkedoneachpipeandfitting:

(a) Internaldiameter;
(b) Grade;

(c) Dateofmanufacture;

(d) Nameofmanufacturerorhisregisteredtrade-markor both.

AllpipesandfittingsshallhaveISImark.

Jointing of GSW pipes and fittings shall be done as per the requirements of the following Employer's RequirementsandtherelevantBIS.Afterjointing,extraneousmaterialifany,shallberemovedfromthe inside of the pipes and fittings and the newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS : 5382.

SpigotandSocketJoint(CementJoint)

Thespigotofeachpipeshallbeslippedhomewellintothesocketofthepipepreviouslylaidandadjusted in the correct position. In each joint, spun yarn soaked in neat cement slurry or tarred gasket shall be passed aroundthe joint and inserted in it bymeans of a caulkingtool.More skeins of yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one-fourth of the depth or socket.

Cement mortar (1:1) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall than be caulked into the joint with a caulkingtool.Morecementmortarshallbeaddeduntilthespaceofjointhasbeencompletelyfilledwith tightly caulked mortar. The joint shall then befinished of neatly outside the socket at an angle of 45 degrees.

Thecementmortarjointsshallbecuredatleastforsevendaysbeforetesting.

Theapproximatequantityofcementrequiredforeachjointforcertaincommonsizesofpipesaregiven below for guidance :

Nominaldiameter of pipe (mm)	**Cement (kg)**
150	1.5
200	2.0
250	2.5
300	3.25

350	4.5
400	5.5
450	6.5

SpigotandSocketJoint(BituminousJoint)

Thematerialforjointingshallconsistofcompositionofasphaltandsandintheratioof1:7.Asphaltand sand shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

SpigotandSocketJoint(RubberRing Joint)

The pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previouslylaid pipe by means of uniformlyapplied pressure with the aid of a jack or similar appliance. The rubber rings conforming to IS : 5382 shall be used, and the manufacturer's instructions shall be deemed to form a part of this Employer’s Requirements. The rubber rings shall belubricated before makingthejoint andthelubricant shall besoft soap water oran approvedlubricant suppliedbythe manufacturer.

CleaningofPipes

As soon as a stretch of GSW pipes has been laid complete from manhole to manhole or for a length as approved by the Employer’s Representative, the Contractor shall run through the pipes both backward and forward a double disc or solid or closed cylinder 50 mm less in diameter than the internaldiameterofpipes.Theopenendofanincompletestretchofpipelineshallbesecurelyclosed as approved by the Employer’s Representative to prevent entry of mud or silt etc.

If as a result of the removal of any obstruction the Employer’s Representative considers that damages mayhavebeencausedtothepipelines,heshallbeentitledtoorderthelengthtobetestedimmediately. Should such test prove unsatisfactory the Contractor shall repair the pipeline andcarry out such further tests as are required by the Employer’s Representative.
It shall also be ascertained by the Contractor that each length frommanhole to

manhole or the length as approved bythe Employer’s Representative is absolutelyclear andwithoutanyobstruction bymeans of visualexaminationoftheinteriorofthepipelinesuitablyilluminatedbyprojectedsunlight orotherwise.

After laying and jointing of GSW pipes is completed the pipe line shall be tested as per the following Employer’sRequirementsandasapprovedbytheEmployer’sRepresentative.Allequipmentfortesting at work site shall be supplied and erected by the Contractor. Water for testing of pipeline shall be arrangedbyhim.DamageduringtestingshallbetheContractor'sresponsibilityandshallberectifiedby himtothefull satisfactionoftheEmployer’sRepresentative.Waterusedfortestshall beremovedfrom pipes and not released to the excavated trenches.

After thejoints have thoroughlyset and have been checked bythe Employer’s Representative and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight. Before commencing the hydraulic test, the pipelines shall be filled with waterand maintained full for 24 hoursbyaddingwater, if necessary, under a head of 0.6 mof water.The test shall be carried out bysuitablyplluggingthe lowend of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed at the top end and a sufficientlengthofverticalpipejointedtoit soastoprovidetherequiredtesthead;orthetopendmaybe plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required headis obtainedandfixed suitablyfor observation.Thepipeline shall besubjectedto atest pressureofat least 2.5 m head of water at the highest point of the section under test. The tolerance of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 minutes. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

Ifanydamageiscausedtothepipelineduringtheexecutionofworkorwhilecleaning/testingthepipeline as specified.TheContractor shallbe heldresponsible for the same andshallreplace thedamaged pipeline and re-test the same to the full satisfaction of the Employer’s Representative.

Waterfortestingofpipelineshallbearrangedbythe Contractor.

StopCockandBib Cock

A bibcock (bibtap) is a draw off tap with a horizontal inlet and free outlet and stopcock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of the screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer,

which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. The cocks shall open in anti-clockwise direction. When the bib cocks and stop cocks are required to bechromiumplated,thechromiumplatingshallbeofserviceGradeNo.2conformingtoIS.1068.

infinishandappearance,theplatedarticlesshallbefreefromplatingdefectssuchas blisters, pits, roughness and shall not be stained or discoloured.

These fittings shall be of brass heavy class, chromium plated (C.P) and of approved manufacture and pattern with screwed of flanged ends as specified. The fittings shall in all respects comply with the requirementsofIS.781.Thestandardsizeofbrassfittingsshallbedesignatedbythenominalboreofthe pipe to which the fittings are attached. A sample of each kind of fitting shall be approved by the Employer's Representative and all supplies made according to the approved samples.

All cast fittings shall be sound and free from laps, blow holes and fittings, both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging stopping or patching of the casting shall not be permitted. The bodies, bonnets, spindles and other parts shall be truly machined and whenassembledthepartsshallbeaxial,parallelandcylindricalwithsurfacessmoothlyfinished.Thearea of the waterway of the fittings shall not be less than the area of the nominal bore.

Thefittingsshallbefullyexaminedandclearedofallforeignmatterbeforebeingfixed.The fittingsshall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be made leak- proof. The joints and fittings shall be leak proof when subjected to a pressure test approved by the Employer's Representative and the defective fittings and joints shall be replaced or redone.

SoakPit

Soak pit shall be constructed at the location specified by the Employer's Representative. Earthwork excavation shall be carried out to the exact dimensions. Brick masonry lining with open joints shall be constructed in the pit upto 150 mm below the outlet pipeline. Brick masonry in cement mortar 1:6 shall be constructed above this level upto ground. Well burnt brick aggregates of nominal size 40 mm to 80 mm and coarse sand shall be filled within the chamber. Construction of pit lining and filling of the brick ballast shall progress simultaneously.

Manholes

Location

Manholesshallbeconstructedatplacesapprovedbytheemployer’sRepresentative.

Excavation

Excavation,shoring,dewateringetc.forthepitsofmanholes,layingofpipesandfittings/ specialsshallbe done in accordance with Employer’s Requirements described elsewhere in the document.

BedConcrete

Thebedconcreteformanholesshallbedoneinaccordancewithemployer’sRequirementsd escribed elsewhere in the document.

Bricks

Bricks used for construction of manholes shall conform to the relevant Indian Standards. They shall be Wire cut bricks/ Table moulded type, sound, hard, homogeneous in texture, well burnt in kiln without being vitrified, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containingungrounded particles and/or which absorbwater more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. Over burnt or under burnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strengthof50kg/sq.cm.unlessotherwisenotedindrawings.Theclassandqualityrequire mentsofbricks shall be as laid down in IS : 1077.

Thesizeofthebrickshallbe23.0x11.5x7.5cm.unlessotherwisespecified;buttoleranceu pto ±3mm in each directionshall be permitted. Onlyfullsize brickshall be used for masonrywork. Brickbats shall be used only with the permission of Employer’s Representative to make up required wall length or for bonding. Sample bricks

shall be submitted to the Employer’s Representative for approval and bricks

suppliedshallconformtoapprovedsamples.IfrequiredbytheEmployer’sRepresentative,bricksample shallbetestedasperIS:3495byContractor.BricksrejectedbytheEmployer’sRepresentativeshallbe removed from the Site within 24 hours.

CementMortar

Mortar for brick masonry shall be prepared as per IS : 2250. Manholes shall be constructed in brick masonry with cement mortar (1:2) unless otherwise specified. Gauge boxes for sand shall be of such dimensions that one bag containing 50 kg. of cement forms one unit. The sand shall be free from clay, shale,loam,alkaliandorganicmatterandshallbeofsound,hard,cleananddurableparticles.Sandshall be as approved by the Employer’s Representative. If required by the Employer’s Representative sand shall be thoroughly washed till it is free of any contamination.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shallthenbeaddedandmixingcontinuedtogiveauniformmixofrequiredconsistency.Cementmortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

TheContractorshallarrangefortestsonmortarsamplesifsorequiredbyEmployer’s Representative. Retempering of mortar shall not be permitted.

BrickMasonry

All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thickbrickworkshallbelaidwithstretchers.Forlayingbricks,alayerofmortarshallbespreadoverthe full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

Allbrickworkshallbeplumbandsquareunlessotherwiseshownondrawingandtruetodimensions shown. Vertical joints in alternate courses shall come directly one over

the other and be in line.
Horizontalcoursesshallbelevelled.Thethicknessofbrickcoursesshallbekeptuniform.Forwallsof thickness greater than 230 mm both faces shall be kept in vertical planes unless otherwise specified.

All interconnectedbrickworkshall becarried out at nearlyonelevel(sothat thereis uniformdistribution of pressure on the supporting structure) and no portion of the work shall be left more than one course lowerthantheadjacentwork.Wherethisisnotpossible, theworkshallberakedbackaccordingtobond (and not saw toothed) at an angle not exceeding 45 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS : 2212.

Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by rakingtoolsdailyduringtheprogressofworkwhenthemortarisstillgreen,soastoprovide aproper key for the plastering to be done. When plastering is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned dailyandall mortardroppingsremoved.Thesurfaceofeachcourseshallbethoroughlycleanedofall dirt before another course is laid on top. If mortar in the lower courses has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.

CementPlaster

Alljointsinmasonryshallberakedtoadepthof12mmwithhookedtoolmadeforthepurpose whenthe mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced.Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniformto get uniform bond between the plaster and the wall.

The proportion of the cement mortar shall be as approved on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar thus mixed shall be used immediatelyandinnocaseshallthemortarbeallowedtoremainformorethan25minutesa ftermixing with water.

Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged.Curingshall bedonebycontinuouslyapplyingwaterinafinesprayandshall becarriedoutfor at least 7 days.

Plasteringshallbedoneonbothfacesofbrickmasonryincement mortar(1:2)and20mmthickunless otherwise specified.

Plasteringworkshall becarriedoutintwolayers,thefirstlayer being14mmthickandthesecondlayer being6 mmthick. Thefirstlayer shall bedashed against the preparedsurface witha trowelto obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise approved by the Employer’s Representative.

CementConcreteChannel

The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channelshallbetakenuptothelevelofthecrownoftheoutgoingsewer.Theyshallbebenched upin concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

PipeEnteringorLeavingManhole

Wheneverapipeentersorleavesamanhole,bricksonedgemustbecuttoaproperformand laidaround the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

PVCencapsulatedRungs

Rungs shall meet the dimensions as specified in IS : 5455. Material shall be in Fe415 or Fe500 plastic encapsulated.Thestepsshallbeclean,wellcastandtheyshallbefreefromairandsandholes,coldshuts and warpings. The portion of the step which projects from the wall of the manhole shall have adequate non-slip grip.

Wherethedepthofinvertofmanholeexceeds800mm,the stepsofapprovedpatternshallbefixedinthe brick work or RCC at the interval of 300 mm vertically and staggered at 380 mm horizontally centre to centre. In case of pipe diameter greater than 600 mm, box type steps shall be provided at 300 mm vertically in channel of manhole.

FrameandCovers

Frameandcoversformanholesshallbeofrequiredtypeanddimensionsaspertherelevantdrawings prepared by the Contractor.Following information shall be clearly marked on each cover.
Yearof manufacture,

Identificationmarkofthepurc

haser, SEWERS/SWD,

Arrowshowingdirectionofflow

CastIronFrameandCover

The cast iron frame and cover shall be of grey cast iron as per IS : 1726. The general requirements for casting and coating of CI frame and cover shall be as specified for CI steps in Clause 7.15.10. The covers shall have a raised chequered design to provide an adequate non-slip grip. The rise of the chequer shall be not less than 4 mm. The locking device for the cover shall be provided as approved by the Employer's Representative. The CIcovers for the load test shall be selectedatoneforeverylotoffiftyor part thereoffor each type and size manufactured andas approvedbytheEmployer'sRepresentative.Theframeshallbefixedincementconcreteof M15 grade all round and finished with neat cement. The manhole frame shall have 560 mm diameter clear opening and shall weigh not less than 208 kg. including cover. In case of rectangular CI frame and cover of 900 mm x 600 mm clear opening, the total weight shall not be less than 275 kg. In case of scraper manhole the frame shall have clear opening of 1200 mm x 900 mm and shall weigh not less than 900 kg including cover. The manhole cover and frame shall be painted with three coats of anti-corrosive paint after fixing in position.

FibreReinforcedConcreteFrameandCover

Fibrereinforcedconcreteframeandcovershallbecapableofwithstandingloadof35 tonnes.The frame shall be fixed in cement concrete of M15 grade all around and finished with neat cement.
The fibre reinforced frame shall have clear opening of 560 mm diameter and weighing 102 kg. The cover shall have a minimum thickness of 100 mm and weighing 78 kg. The fibres shall constitute 1% of the weight of the concrete

in the form of 50 mm to 100 mm long high tensile steelwires.Forthecover,MSsheetlappingof18gaugeshallbeprovidedtoavoidda magetothe edges. Similarly for frame, MS angle/flat shall be provided along the edge. Both MS sheet and

angleshallbepaintedwithblackbituminouspaint.Thecovershouldhavesuitablelifting arrangement. The fibre reinforced frame and cover shall be manufactured as approved.

ReinforcedCementConcreteFrameandCover

Reinforced cement concrete frame and cover for manholes shall be of required dimensions and shapeasshownonthedrawingpreparedbytheContractor.Theframeandcovershall becastin cement concrete of M25 grade. Minimum cover to

the reinforcement shall be 40 mm. The edges of frame and covers shall be provided with mild steelanglestoavoiddamagestothecorners.Theseanglesshallbepaintedwithblackbituminous paint. The covers should have suitable lifting arrangement.

Drop Manhole

When a sewer connects a main sewer, andwhere the difference in level between water line (peak flow levels) of main line and the invert level of branch lines is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connectionwithin600mm, adropconnectionshallbeprovidedforwhichamanholeshallbeconstructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. This pipe shall be provided outside the shaft and encased in concrete. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with ahalf blankflange.The diameter ofthe backdropshould beatleast as largeas that oftheincoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer. The pipe unless of cast iron should be surrounded with 150 mm thick concrete.

Inthecaseofsewersover450mmindiameterthedropinlevelmaybeaccomplishedbyoneoft he following approved methods:

(a) Acascade;
(b) Aramp;
(c) Bydropsinprevious manholes.

RCCManhole

M30gradeofconcreteusedforconstructionofRCCmanholeshallhaveminimumcementcontentof400 kg/cum of concrete.Minimum cover to the reinforcement shall be 50 mm.

VentShafts

General

Ventshaftsshallbeerectedatsuchplacesasapprovedbytheemployer's Representative.

MildSteelVentShaft

Mildsteelventshaftshallbeof150mmdiameterand12.17mheightfromgroundlevel with C.I. ornamental cap. This shall be fixed firmly and encased in cement concrete of M15gradeasshownonrelevant drawingwithnecessarymildsteel bolts,platesetc.for foundation.Thevent shaftshall bepaintedwithonecoat ofsilver paint over onecoatof red leadoxide paint.The vent shaft shall be connected to manhole by 150 mmdiameter glazed stoneware pipe encased by M10 concrete of 150 mm thickness all around as approved by the Employer's Representative.

RCCVentShaft

ReinforcedcementconcreteventshaftshallbeofM30gradeconcrete,200 mmdiameter at bottom and tapered to 100 mm diameter at top (both inside clear openings) and 6 m height from ground level. The vent shaft shall be embedded in concrete ofM10 grade and anchored by 2 nos. of 16 mm diameter and 600 mm long MS bars. The vent shaft shall be connected to manhole as specified in (b) above through a brick masonry flue chamber.

Miscellaneous

If any damage is caused to the other services such as water supply pipeline, sewer, cable, etc. during the construction of manholes and erection of vent shafts, the Contractor shall be held responsible for the same and shall replace the damaged services to the full satisfaction of the Employer's Representative.

Theinteriorofmanholesshallbeclearedofalldebrisafterconstructionandbeforetestingthesamefor water tightness by the Contractor.

Measurementfor Pipes

AC,CastironandS.W.drainagepipesshallbemeasuredalongthecentrelinesofpipesincluding all fittings such as junctions, plug bends etc., for which no separate payment shall be made.

GI pipes with fittings completely fixed in position shall be measured and paid for the finished centrelinelengths,includingallfittingssuchastees,bends,couplingsetc.,forwhichnoseparate payment shall be made.

In measuring the lengths of sewer pipes laid, length between faces of manholes shall be considered.Inspectionchambersshallonlybemeasuredomittinglengthsofchannelsbetween inside faces of walls of manholes of chambers.

EndofSection-7

SECTION 8

GENERALCIVILWOR

KS

SECTION8

GENERALCIVILWORKS

ApplicableCodesandSpecifications

Thefollowingcodesandstandards areincludedinthis section.

IS:110 -

Readymixedpaint,brushing,greyfiller,forenamelsforuseoverprimers

IS:269 - Specification for Ordinary Portland cement

IS:280 - Specificationformildsteelwireforgeneralengineeringpurposes

IS:287 -

Recommendationsformaximumpermissiblemoisturecontentof timberused for different purposes

IS:304 - HighTensileBrassIngotsandCastings.

IS:337 -

Varnish,finishinginterior

IS:348 - French polish

IS:383 -

Specificationforcoarseandfineaggregatesfromnaturalsourcesforconcrete

IS:412 - Expanded metal steel sheets for general purposes

IS:419 -

Specificationforputtyforuseonwindowframes IS:428

- Distemper, oil emulsion, colour as required

IS:459 - Specificationforunreinforcedcorrugatedandsemi-corrugatedasbestoscementsheets

IS:702 -

Specificationforindustrialbitumen IS:710 -

Specification for marine plywood IS:712 - Specification for building limes

IS:730 - Specificationfor hookboltsforcorrugatedsheetroofing

IS:733 -

Wroughtaluminiumandaluminiumalloys,bars,rodsandsections forgeneral engineering purposes

IS:777 - Specificationforglazedearthenwaretiles

IS:1003 -

Specificationfortimberpanelledandglazedshutters(Parts1&2)

IS:1038 - Specification for steel doors, windows and ventilators

IS:1077 - Specificationfor commonburnt claybuilding bricks

IS:1081 - Codeofpracticeforfixingandglazingofmetal(steel&aluminium)doors, windows and ventilators
IS:1124 - Methodoftestfordeterminationofwaterabsorption,apparentspecificgravity and porosity of natural building stones
IS:1237 - Specification for cement concrete flooring tiles IS:1322 - Bitumenfeltsforwaterproofinganddampproofing
IS:1346 - Codeofpracticeforwaterproofingofroofswithbitumenfelts
IS:1361 - Specification for steel windows for industrial buildings IS:1397- Specification for kraft paper
IS:1443 - Codeofpracticeforlayingandfinishingofcementconcreteflooringtiles
IS:1477 - Code of practice for painting of ferrous metals in buildings (Parts 1 & 2) IS:1542 - Specification for sand for plaster
IS:1580 - Specificationforbituminouscompoundsforwater-proofingandcaulking purposes

IS:1597 -

Codeofpracticeforconstructionofstonemasonry:Part1Rubblestone masonry
IS:1659 - Specificationforblock boards
IS:1661 - Codeofpracticeforapplicationofcementandcement-limeplasterfinishes IS:1834 - Specification for hot applied sealing compound for joint in concrete
IS:1838 - Specification forpreformed fillers for expansion joint in concrete pavements andstructures(nonextrudingandresilienttype):Part1Bitumenimpregnated fibre
IS:1948 - Specification for aluminium doors, windows and ventilators IS:1949 - Specification for aluminium windows for industrial buildings IS:2074 -

Readymixedpaint,airdrying,redoxide-zincchrome,priming IS:2098 - Asbestos cement building boards

IS:2114 - Codeofpracticeforlayingin-situterrazzofloorfinish IS:2116 - Specification for sand for masonry mortars
IS:2185 - Specificationforconcretemasonryunits(Parts 1,2 &3)
IS:2202 -

Specificationforwoodenflushdoorshutters(Solidcoretype):Parts1&2
IS:2212 - Code of practice for brickwork
IS:2250 - Codeof practiceforpreparationand useof masonrymortars
IS:2338 -

Codeofpracticeforfinishingofwoodandwoodbasedmaterials(Parts1&2)
IS:2339 - Aluminium paint for general purposes, in dual container
IS:2395 -

Codeofpracticeforpaintingconcrete,masonryandplastersurfaces(Parts1&2)
IS:2402 - Codeofpracticeforexternalrenderedfinishes
IS:2571 - Codeofpracticeforlayingin-situcementconcreteflooring IS:2645 - Specification of integral cement waterproofing compounds
IS:2690 -

Specificationforburntclayflatterracingtiles:Part1Machinemade
IS:2691 - Specification for burnt clay facing bricks
IS:2750 -

Specificationforsteelscaffoldings IS:2835 - Flat transparent sheet glass
IS:2932 - Specificationforenamel, synthetic,exteriortype(a)undercoating, (b)finishing

IS:3007 - Code of practice for laying of asbestos cement sheets - corrugated and (Part 1 &2) semi-corrugated sheets

IS:3036 - Code of practice for laying lime concrete for a water-proofed roof finish IS:3067 -

Codeofpracticeofgeneraldesigndetailsandpreparatoryworkfordamp-proofingand water-proofingof buildings

IS:3068 -

Specificationforbrokenbrick(burntclay)coarseaggregatesfor useinlime concrete

IS:3384 - Specificationforbitumenprimerforuseinwater-proofinganddamp-proofing IS:3461 - Specification for PVC-asbestos floor tiles

IS:3462 - Specification for unpacked flexible PVC flooring IS:3495 -

Methodoftestforburntclaybuildingbricks:Part1to4

IS:3536 -

Specificationforreadymixedpaint,brushing,woodprimer,pink

IS:3564 - Specification for door closers (hydraulically regulated)

IS:3614 (Part – 1) - Specification for fire checks doors : Part –I Plate metal covered and rolling type

IS: 3614 (Part – 2) - Specificationformetallicandnon-metallicfirecheckdoors:Part-2 Resistance test and performance criteria

IS:3696 - Safetycodeofscaffoldsandladders(Parts1&2)

IS:4020 - Methodsof testforwoodenflushdoor: Typetest

IS:4021 - Specificationfortimberdoor,windowandventilatorframes

IS:4351 - Specification for steel door frames

IS:4443 - Codeofpracticeforuseofresintypechemicalresistantmortars

IS:4457 - Specification for ceramic unglazed vitreous acid resisting tile

IS:4631 - Code of practice for laying epoxy resin floor toppings

IS:4832 - Specificationforchemicalresistantmortars(PartII)

IS:4860 - Specification for acid resistant bricks

IS:4948 - Specificationforwelded steel wirefabricfor generaluse

IS:5318 - CodeofpracticeforlayingofflexiblePVCsheetandtileflooring

IS:5410 - Cement paint, colour as required

IS:5411 - Specificationforplasticemulsionpaint(Parts1&2)

IS:5437 - Wired and figured glass

IS:5491 - Code of practice for laying of in-situ granolithic concrete floor topping

IS:6041 - Codeofpracticeconstructionofautoclavedcellularconcreteblockmasonry

IS:6042 - Code of practice for construction of light weight concrete block masonry

IS:6248 - Specification for metal rolling shutters and rolling grilles

IS:7193 - Specificationfor glassfibrebase coaltarpitchandbitumenfelts

IS:7452 - Specificationforhotrolledsteelsectionsfordoors,windowsandventilators

IS:8042 - Specification for white Portland cement

IS:8543 - Methodsoftestingplastics

IS:8869 - Specificationforwashersforcorrugatedsheetroofing

IS: 9197 - Specificationforepoxyresin,hardenersandepoxyresincompositesforfloor topping

IS:9862 - Specificationforreadymixedpaint,brushing,bituminous,black,lead-free, acid, alkali, water and chlorine resisting

IS:12200 - Codeofpracticeforprovisionofwaterstopsattransversecontractionjointsin masonry and concrete dams

BS: 476 (Part – 20) - Methodsfor determinationofthefireresistance ofelements ofconstruction (General Principles)

BS: 476 (Part – 21) - Methodsfor determinationof thefireresistanceofloadbearingelementsof construction

BS: 476 (Part – 22) - Methodsfordeterminationofthefireresistanceofnon-loadbearing elements of construction

Part– IV - NationalBuildingcodeofIndia (Fire Protection)

Brickwork

Materials

Bricksusedintheworksshallconformtotherequirementslaiddown inIS:1077.Theclassof the bricks shall be as specifically indicated in the respective items of work.

The nominal size of the modular brick shall be 200mmx100mmx100mm with the permissible tolerancesovertheactualsizeof190mmx90mmx90mmasperIS:1077.Thenomin

althickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230 mmx115mmx75mm with tolerance upto ±3 mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively.
Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall havesharpandsquareedgeswithsmoothrectangularfaces.Thebricksshallbefrefrompores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the items of work.
Theaveragewaterabsorptionshallnotbemorethan20percentbyweightuptoclass 12.5and15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.
SamplebricksshallbesubmittedtotheEngineerforapprovalandbrickssupplieds hallconform toapprovedsamples.IfdemandedbyEngineer,bricksamplesshallbegottestedas perIS:3495 by Contractor. Bricks rejected by Engineer shall be removed from the site of works within 24 hours.
Mortarforbrickmasonryshallconsistofcementandsandandshallbepreparedas perIS:2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work. Sand for masonry mortar shall conform to IS: 2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles.
SandshallbeapprovedbyEngineer.IfsodirectedbytheEngineer,sandshallbescreenedand washed till it satisfies the limits of deleterious materials.
For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the Engineer. The mortar thus mixed shall be used as soon as possible, preferably within30minutesfromthetimewaterisaddedto cement. Incase,themortarhasstiffeneddueto evaporationofwater,thismaybere-temperedbyaddingwaterasrequiredtorestoreconsistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to

cement.Anymortarwhichispartiallysetshallberejectedandshallberemovedfort
hwithfrom the site. Droppings of mortar shall not be re-used under any circumstances.
TheContractor shallarrangeforteston mortar samplesif so directedbytheEngineer.

Workmanship

Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughlysoaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightlypressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricksshallbeusedfortheworksandcutbricksutilisedonlytomakeuprequiredwa lllengthor for bonding. Bricks shall be laid with frogs uppermost.
All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. Thethickness of brick courses shall bekept uniform. In caseof onebrick thick or half brick thick wall, atleast one face should be kept smooth and plane, even if the other is slightly
roughduetovariationinsizeofbricks.Forwallsofthicknessgreaterthanonebrick bothfaces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearlyone level so that there is uniform distribution of pressure on the supportingstructure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one metre. Brick work shall not be raised more than one metre per day.
Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm byraking tools during the progress of work when the mortar is still green, so as toprovideaproperkeyfortheplastering/pointingrespectivelytobedonelater.Wh enplastering or pointingis not required to be done, the joints shall be uniform in thickness and bestruck flush and finished at the time of laying.
The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.
Duringinclementweatherconditions,newlybuiltbrickmasonryworksshallbeprot ectedby tarpaulin or other suitable covering to prevent mortar being washed away by rain.
Brickworkshallbekeptconstantlymoistonallthefacesforatleastsevendaysafter2 4hrsof laying. The arrangement for curing shall be got approved from the Engineer.
Double scaffolding having two sets of vertical supports shall be provided to

facilitate execution ofthemasonryworks.Thescaffoldingshallbedesignedadequatelyconsideringall thedead,live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696 (Part I). Scaffolding shall be properly maintained during the entireperiodof construction.Singlescaffoldingshallnotbe usedonimportantworksandwillbe permitted only in certain cases as decided by the Engineer. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/pointing.

Intheeventofusageoftraditionalbricksofsize230mmx115mmx75mm,thecoursesatthetop oftheplinthandsillsaswellasatthetopofthewalljustbelowtheroof/floorslabsand atthetop of the parapet shall be laid with bricks on edge.
All brickwork shall be built tightly against columns, floor slabs or other structural members.Toovercomethepossibilityofdevelopmentofcracksinthebrickmasonryfollowingmeasures shall be adopted.
ForrestingRCCslabs,thebearingsurfaceofmasonrywallshallbefinishedontopwith12mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.
RCC/ steel beams resting on masonrywall shall beprovided with reinforced concretebed blocks of 50 mm thickness, projecting 50mm on either sides of the beam, duly finished on top with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.
Steelwirefabricshallbeprovidedatthejunctionofbrickmasonryandconcretebeforetakingup plastering work.
Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half orfullbrickwallsabuttingagainsteitherade-shutteredslaborbeamshall bebuiltonlyafterany proposedmasonrywallabovethestructuralmemberisexecutedtocaterfor thedeflectionofthe structural element.
Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction Drawings are generallyrequired to be provided in the half brick partition walls. Where the drawings indicate that structural steel sections are to be encased in brickwork, the brick masonryshall be built closelyagainst the steel section, ensuring a minimum of 20 mm thick cement-sand mortar 1:4 over all the steel surfaces.Steel sections partly embedded in brickworkshallbeprovidedwithbituminousprotectivecoatingtothesurfacesatthepointof entry into the brick masonry.
Contractor shall note that the unit rates quoted for the masonrywork shall bedeemed to include for the installation of miscellaneous inserts such as pipe sleeves, bolts, steel sections with anchors etc. and provide pockets, leaving openings, cutting chases etc. in accordance with the construction drawings. Miscellaneous inserts shall beeither supplied free bythe Employer or to be furnished by the Contractor. Any of the miscellaneous inserts which are required to be fabricatedandsuppliedbytheContractorandcementconcretetobeprovidedinthepocketsfor holdfasts of door/window frames etc. shall however, be measured and paid for separatelyunder the respective items of work.
FacingbricksofthetypespecifiedconformingtoIS:2691shallbelaidinthepositionsindicated on the drawings and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.
Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix,

thicknessofjointandthetypeofpointingtobecarriedoutshallbeasspecifiedinthei temof works. The pattern of laying the bricks shall be as specifically indicated in the drawings.
Forfacingbrickwork,doublescaffoldingshallbeused.
Facedworksshallbekeptcleanand freefromdamage,discoloration etc., atall times.

Measurement

Measurementshallbeincu.mcorrecttotwoplacesofdecimalforbrickworkofthickn essone brick i.e. 200 mm/230 mm and above.Measurement shall be in sq. m correct to two places

decimal for facing brickwork and brickwork of thickness half brick i.e. 100mm/115mm and below.Measurement shall be for the quantities as actually executed duly deducting for openings,lintels,transoms/mullionsetc.Allconcreteworksshallbemeasuredan dpaid for separately under the respective items of work.

UncoursedRandomRubbleMasonryinFoundation,PlinthandSuperstructure

Materials

Stones for the works shall be of the specified variety which is hard, durable, fine grained and uniform in colour (for superstructurework) free fromveins, flaws and other defects. Quality and work shall conform to the requirements specified in IS:1597 (Part-I). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124. The Contractor shall supply sample stones to the Engineer for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sandmortarforstonemasonryworksshallbeintheproportionof1:6.Materialsand preparation of mortar shall be as specified in clause 8.2.1.

Workmanship

Forallworksbelowgroundlevelthemasonryshallberandomrubbleuncoursedwith ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.

For all works above ground level and in superstructure the masonry shall be random rubble uncoursed, well bonded, faced with hammer dressed stones with squared quoins at corners. The bushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastereditshallnotprojectbymorethan12mm norshallithavedepressionsmorethan10mm from the average wall surface. Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greaterthanthree-fourthsthethicknessofwallnorlessthan150mm.Theheightofstonemaybe up to a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm inany direction.

Chipsandspallsshallbeusedwherevernecessarytoavoidthickmortarjointsandt oensurethat no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flushandfinishedastheworkproceeds.Otherwise,thejointsshallberakedtoamini mumdepth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Throughorbondstonesshallbeprovidedinwallsupto600mmthickandincaseofw

allsabove 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc.) the bond stone shall extend about two-thirds into the wall and a set of two or more bond stones overlapping each other by at least 150 mm shall be provided.
Eachbond stoneor asetofbond stones shallbe provided forevery0.5 sq.m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly.
Howeverifanypartofthemasonryisrequiredtobeleftbehind,thewallshallberakedback (and not saw toothed) at an angle not exceeding45deg.
Masonrywork shall not be raised by more than one metre per day.
Green work shall be protected from rain by suitable covering. Masonry work shall be kept
constantlymoistonallthefacesforaminimumperiodofsevendaysforproper curingofthe joints.
Typeof scaffoldingto be used shallbeasspecified inclause8.2.2.

Measurement

Measurementshallbeincu.mcorrecttotwoplacesofdecimal.Thequantitiesmeasuredand paid for, shall be those as actuallyexecuted after making necessarydeductions for openings, lintels etc.

CoursedRubbleMasonry(FirstSort)forSuperstructure

Materials

TheMaterialspecificationfor theworkshallbeasperclause8.3.1.

Workmanship

All courses shall be laid truly horizontal and shall be of the same height in any course. The
heightofcourseshallnotbelessthan150mmandnotmorethan300mm.Thewidth ofstone shall not be less than its height.
Facestoneshalltailintotheworkfornotlessthantheirheight andatleast 1/3rdthenumber of stones shall tail into the work for a length not less than twice their height but not more than three-fourthsthethicknessofthewallwhicheverissmaller.Theseshouldbelaidasheadersand stretchers alternately to break joints by at least 75 mm.
The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel
dressedtrueandsquareforatleast80mmbackfromthefaceandthesidejointsforatleast40
mm.Thefaceofthestoneshallbehammerdressedsothatthebushingshallnotbemorethan40 mm on an exposed face and 10 mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints.
No spalls or pinning’s shall be allowed on the face. All bed joints shall be horizontal and side
jointsshallbeverticalandnojointsshallbemorethan10mminthickness.Whenplasteringor pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.
Heartingshallconsistofflatbeddedstonescarefullylaidontheirproperbedsandsolidlybedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not

exceed 10 percent of the quantity of the stone masonry.
Careshall betaken sothat nohollowspaces areleftanywhereinthemasonry.
Therequirementregardingthroughorbondstonesshallbeasspecifiedinclause8.3.
2withthe further stipulation that these shall be provided at 1.5 m to 1.8m
apart clear in everycourse but staggered at alternate courses.

Thequoinswhichshallbeofthesameheightasthecourseinwhichtheyoccur,shallnotbeless than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately.
Theyshall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100mmfromtheface.Thesestonesshallhaveminimumuniformchiseldraftsof25mmwidthat four edges, all the edges being in the same plane.
Typeof scaffoldingto be used shallbeasper Clause 8.2.2.
Requirementsofexecution ofthe workandcuringshallbe as stipulatedin clause8.3.2 .

Measurement

Measurementshallbeincu.mcorrecttotwoplacesofdecimal.Thequantitiesmeasuredand paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

ConcreteBlockMasonry

Materials

Masonryunitsofsolidconcreteblocksshallconformtotherequirementsof IS:2185(Part1). Masonry units of solid light-weight concrete blocks shall conform to the requirements of IS : 2185 (Part 2).
Masonryunitsofautoclavedcellularconcreteblocksshallconformtotherequirementsof IS:2185 (Part 3).
Theheightoftheconcretemasonryunitsshallnotexceed eitheritslengthorsixtimesitswidth. The nominal dimensions of concrete block shall be as under.

Length400,500 or600mm
Height100 or200mm
Width100 to 300 mm in50 mm increments

Halfblocksshallbeinlengthsof200,250or300mmtocorrespondtothefulllengthblocks. Actual dimensions shall be 10mm short of the nominal dimensions.
Themaximumvariationinthelengthoftheunitsshallnotbemorethan±5mmandmaximum variation in height or width of the units shall not be more than ± 3mm.
Concrete blocks shall be of solid blocks and shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall as specified.Thefacesoftheunitsshallbeflatandrectangular,oppositefacesshallbeparalleland all arises shall be square. The bedding surfaces shall be at right angles to the faces of the block. The concrete mix for the solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume.
Concrete blocks shall be of approved manufacture, which satisfythe limitations in the values of waterabsorption,dryingshrinkageandmoisturemovement,asspecifiedforthetypeofblockas perrelevantIScode.Contractorshallfurnishthetestcertificatesandalsosupplythesamplesfor the approval of Engineer.

Workmanship

The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified. The minimum nominal thicknessofnon-loadbearinginternalwallsshallbe100mm.Theminimumnominalthicknessof external panel walls in framed construction shall be 200 mm.

The workmanship shall generally conform to the requirements of IS: 2572 for concrete block masonry,IS:6042forlightweightconcreteblockmasonryandIS:6041forautoclavedcellular concrete block masonry works.
Fromconsiderationsofdurability,generallyconcreteblockmasonryshallbeused in superstructure works above the damp-proof course level.
Concreteblocksshallbeembeddedwithamortarwhichisrelativelyweakerthanthemixofthe blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works. Preparation of mortar shall be as specified in clause 8.2.1.
The thickness of both horizontal and vertical joints shall be 10mm. The first course shall be laid with greater care, ensuring that it is properly aligned, leveled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding)joint,mortarshallbespreadovertheentiretopsurfaceoftheblockincludingfrontand rearshellsaswellasthewebstoauniformlayer of10mm.Forverticaljoints,themortarshallbe appliedontheverticaledgesofthefrontandrearshellsoftheblocks.Themortarmaybeapplied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weathertight joint. The mortar shall beraked to a depth of 10mm as each courseis laid to ensure good bond for the plaster.
As per the design requirements and to effectively control cracks in the masonry, RCC bound beams/studs,jointreinforcementshallbeprovidedatsuitablelocations.Jointreinforcementshall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed basis as per the drawings.
At intersection of walls, the courses shall laid up at the same time with a true masonry bond betweenatleast50%oftheconcreteblocks.Thesequenceforconstructionofpartitionwallsand treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 8.2 for the brick work.
Curingofthemortarjointsshallbecarriedoutforatleast7days.Thewallsshouldonlybe lightly moistened and shall not be allowed to become excessively wet.
Double scaffolding as per clause 8.2.2 shall be adopted for execution of block masonry work.
Cuttingoftheunitsshallberestrictedtoaminimum.Allhorizontalandverticaldimensions shall be in respectively, adopting modular co-ordination for walls, opening locations for doors, windows etc.

Concreteblocksshallbestoredatsitesuitablytoavoidanycontactwithmoisturefromthe ground and covered to protect against wetting.

Measurement

Measurement shall be in cu. m. correct up to two places of decimal for walls of thickness 200 mm and above.Measurement shall be in sq.m correct upto two places of decimal for walls of 100mm/150mminthickness.Measurementshallbeforthequantitiesasactuallyexecutedduly deducting for openings and concrete works.Concrete and reinforcement will be measured and paid for separately.The rate quoted shall be for the type of masonry blocks specified in the

respectiveitemsofworkwhichshallincludeforthespecificsequentialoperations asstipulated in the construction drawings.

Damp-ProofCourse

Materialsand Workmanship

Where specified, all the walls in a building shall be provided with damp-proof course cover plinthtopreventwaterfromrisingupthewall.Thedamp-proofcourseshallrunwithoutabreak throughout the length of the wall, even under the door or other openings.Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water- proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm down graded coarse aggregates.

Thesurfaceof brick work/stonemasonrywork shall beleveled and prepared beforelayingthe cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak throughandisalsonotdisturbedduringcompaction.Theupperandsidesurfacesh allbemade rough to afford key to the masonry above and to the plaster. Damp-proofcourseshallbecuredproperlyforatleastsevendaysafterwhichitshallbeallo wed to dry for taking up further work.

Measurement

Measurementofdamp-proofcourseshallbeinsq.mcorrecttotwoplacesofdecimalasactually executed.No separate payment will be made for formwork.

MiscellaneousInserts,Boltsetc.

All the miscellaneous inserts such as bolts, pipes, plate embedment etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the constructiondrawings.Contractorshallprepareandusetemplatesforthispurpos e,ifsodirected by the Engineer.In the event, of any of the inserts are improperly installed, Contractor shall make necessary arrangements to remove and reinstall at the correct locations/levels, all as directed by the Engineer without any extra cost to the Employer.

Measurement

Miscellaneousinserts,suppliedbytheContractorshallbemeasuredandpaidforas perthe respective items of work.

WoodWorkinDoors,Windows,Ventilators&Partitions

Materials

Timber to be used shall be first class Teak wood as per IS:4021. Timber shall be of the best quality and well seasoned by a suitable process before being planed to the required sizes. The maximum permissible moisture content shall be from 10 to 16 percent for timber 50mm and above in thickness and 8 to 14 percent of timber less than 50mm in thickness for different regions of the country as stipulated in IS:287. Timber shall be close grained, of uniform colour

andfreefromdecay,fungalgrowth,boxedheart,pitchpocketsorstreaksontheexposededges, borer holes, splits and cracks.
FlushdoorshuttersofthesolidcoretypewithplywoodfacepanelsshallconformtoIS:2202 (Part 1) and with particle board/hard board face panels shall conform to IS: 2202 (Part 2).
TransparentsheetglassshallconformtotherequirementsofIS:2835.Wiredandfiguredglass shall be as per IS: 5437.

Builder’shardwareforfittingsandfixturesshallbeofthebestqualityfromapproved manufacturers.

Workmanship

Theworkmanshipandfinishofwoodworkindoors,windows,ventilatorsandpartitionsshallbe of a very high order. Contractor shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters. Allworksshall beexecutedas perthedetaileddrawingsand/orasdirectedbythe Engineer.

All members of the door, window, and ventilator shall be straight without any warp or bow and shallhavesmoothwellplanedfaces.Therightangleshallbecheckedfromtheinsidesurfacesof the respective members of the frame. Frames shall have mortice and tenon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of framesshallberebatedonthesolidforkeyingwiththeplasterandforreceivingthesh utters.The depth of rebate for housing the shutter shall be 15 mm.The size of the frames shall be as specified in the respective items of work. The workmanship shall generally conform to the requirements specified in IS:4021.

Thefaceoftheframesabuttingthemasonryorconcreteshallbeprovidedwithacoatofcoal tar. Threeholdfastsusing25 mmx 6mmmildsteelflats225mmlongwithsplitendsshallbefixed oneachsideofdoorand windowframes,oneatthecentreandtheothertwoat300mmfromthe topandbottomoftheframe.Forwindow andventilatorframeslessthan1 minheight,twohold fasts on each side shall be fixed at quarter points.

Timber panelled shutters for doors, windows and ventilators shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the drawings. Thestilesandrailsshallbejoinedbymorticeandtenonjointsatrightangles.Allmembersofthe shutter shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than ± 3 mm. Timberpanels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall generally conform to the requirements specified in IS: 1003 (Parts 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as specified. Marine plywood panels conforming to IS: 710 shall be used for doors where specified.

Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, viewing glazed panel, venetian louvre opening, teak wood lipping etc. shall be as specified. Panels of shutter shall be of marine plywood conforming to IS: 710.

Flushdoorshuttersshallbefromreputedmanufacturersand Contractorshallsub

mittestresults as per IS: 4020, if so desired by the Engineer.
Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass,wiredorfiguredglass.Transparentsheetglassshallbeof'B'qualityasperIS: 2835.The thickness and type of glazing to be provided shall be as specified in the item of work.
The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidisedoranodisedaluminiumshallbeasspecified.Thenumber,sizeand typeofthefittings and fixtures shall be as indicated in the drawings/item of work.

Wood work shall not be provided with the finishes of painting/varnishing etc. unless it has been approvedbytheEngineer.Thetypeoffinishandthenumberofcoatsshall beasstipulatedinthe respective items of work.
Woodenhandrailingandarchitravesshallbeofthesizeandshapewiththefixinga rrangement as indicated in the drawings.
The framework of the partitions with mullions and transomes shall be with the sections of dimensionsasspecified.Panelsofdouble/singleglazing/plywoodshallbefixedaspe rdetails specified. Partitions shall be fixed rigidly between the floor and structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the Construction drawings.
Any carpentry work which shows defects due to inadequate seasoning of the timber or bad workmanshipshallberemovedandreplacedbyContractorwithworkasperSpecific ationsatno extra cost to the Employer.

Measurement

Measurement for doors, windows, ventilators, architraves and partitions shall be in sq.m correct to two places of decimal. Handrailing shall be measured in running metres correct to two places ofdecimal.Measurementshallbefromouttooutoftheframes.Ratesquotedshallb eforallthe works including glazing, painting, Builder’s hardware of fittings and fixtures as specifically described in the respective items of work.

SteelDoors,WindowsandVentilators

Materials

Hotrolledsteelsectionsforthefabricationofsteeldoors,windowsandventilatorss hallconform to IS: 7452 which are suitable for single glazing.
Pressedsteeldoorframesforsteelflushdoorsshallbeoutof1.25mmthickmildsteels heetsof profiles as per IS : 4351.
TransparentsheetglassshallconformtotherequirementsofIS:2835.Wiredandfig uredglass shall be as per IS: 5437.
Builder’shardwareoffittingsandfixturesshallbeofthebestqualityfromtheapprov ed manufacturers.

Workmanship

Allsteeldoors,windowsandventilatorsshallbeofthetypeasspecifiedintherespe ctiveitems of work and of sizes as indicated in the drawings.Steel doors, windows and ventilators shall conform to the requirements as stipulated in IS : 1038.Steel windows shall conform to IS : 1361, if so specified.
Doors, windows and ventilators shall be of an approved manufacture.Fabrication of the unit shallbewithrolledsection,cuttocorrectlengthsandmitred.Cornersshallbeweld edtoforma solid fused welded joint conforming to the requirements of IS : 1038. Tolerance in overall dimensions shall be within ±1.5mm.The frames and shutters shall be free from wrap or buckle and shall be square and truly plain.All welds shall be dressed flush on exposed and contact surfaces.Punching of holes,

slots and other provisions to install fittings and fixtures later shall be made at the correct locations as per the requirements.Samples of the units shall be got approved by the Engineer before further manufacture/purchase by the Contractor.

Type and details of shutters, hinges, glazing bar requirement, couplings, locking arrangement, fittingsandfixturesshallbeasdescribedintherespectiveitemsofworkand/orasshowninthe drawings for single or composite units.
Forwindowswithflyproofmeshaspertheitemofwork,rotoroperatorarrangement, forthe operation of the glazed shutters from the inside shall be provided.
Pressed steel door frames shall be provided with fixing lugs at each jamb, hinges, lock-strike plate, mortar guards, angle threshold, shock-absorbers of rubber or similar material as per the requirements of IS : 4351.Pressed steel door frames shall be fixed as `built-in' as the masonry workproceeds.Afterplacingitplumbatthespecifiedlocation,masonrywallsshall bebuiltup solid on either side and each course grouted with mortar to ensure solid contact with the door frame, without leaving any voids.Temporary struts across the width shall be fixed, during erection to prevent bow/sag of the frame.
Doorshuttersofflushweldedconstructionshallbe45mmthick,fabricatedwithtwooouterskins of 1.25mm thick steel sheets, 1mm thick steel sheet stiffeners and steel channels on all four edges.Double shutters shall have meeting stile edge bevelled or rebated.Provision of glazed viewing panel, louvers shall be made as per the items of works and/or drawings.Shutters shall be suitably reinforced for lock and other surface hardware and to prevent sagging/twisting.
Singlesheetsteeldoorshuttersshallbefabricatedoutof1.25mmthicksteelsheets, mildsteel angles and stiffeners as per the drawings.
Doors, windows and ventilators shall be fixed into the prepared openings.They shall not be 'built-in' as the masonry work proceeds, to avoid distortion and damage of the units.The dimensionsofthemasonryopeningshallhave10mmclearanceall-roundtheoveralldimensions oftheframeforthispurpose.Anysupportofscaffoldingmembersontheframes/glazingbarsis prohibited.
Glazing of the units shall be either with flat transparent glass or wired / figured glass of the thicknessasspecifiedintheitemsofworks.Allglasspanelsshallhaveproperlysquaredcorner and straight edges.Glazing shall be provided on the outside of the frames.
Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS:419 or withmetalbeads.Pre-formedPVCorrubbergasketsshallbeprovidedforfixingthebeadswith the concealed screws.The type of fixing the glazing shall be as indicated in the items of work and/or in drawings.
Steeldoors,windowsandventilatorsshallbeprovidedwithfinishofeitherpaintingasspecified or shall be hot dip galvanised with thickness of the zinc coating as stipulated all as described in the respective items of works.
The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidised or anodised aluminium shall be as specified in the items of works. The number, size and type of fittings and fixtures shall be as in the Drawings /items of work. Installation of the units with fixing lugs, screws, mastic caulking compound at the specified locationsshallgenerallyconformtotherequirementsofIS:1081.Necessaryholes

etcrequired for fixing shall be made by the Contractor and made good after installation.Workmanship expected is of a high order for efficient and smooth operation of the units.

Measurement

Measurementshallbeinsq.mcorrecttotwoplacesofdecimal.Measurementshallbefromout to out of the frames.Rates quoted shall be for the works including glazing, painting, Builder’s hardware of fittings and fixtures as specifically described in the respective items of work.

AluminiumDoors,Windows,Ventilators&Partitions

Materials

Aluminumalloyusedinthemanufactureofextrudedsectionsforthefabricationof doors, windows, ventilators shall conform to designation HE9-WP of IS:733. TransparentsheetglassshallconformtotherequirementsofIS:2835.Wiredandfi guredglass shall be as per IS:5437.
Builder'shardwareoffittings&fixturesshallbeofthebestqualityfromapproved manufacturers.

Workmanship

All aluminum doors, windows, ventilators and partitions shall be of the type and size as
specified.Thedoors,windows,ventilatorsshallconformtotherequirementsofIS: 1948. Aluminum windows, shall conform to IS:1949, if so specified.
Allaluminumunitsshallbesuppliedwithanodizedfinish.Theminimumanodicfilmt hickness shall be 0.015 mm.
Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitred and welded at the corners to a
truerightangleconformingtotherequirementsofIS:1948.Toleranceinoveralldi mensionsshall be within ± 1.5mm. The frames and shutters shall be free from warp or buckle and shall be square and trulyplane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements.
Aluminiumswingtypedoors,aluminumslidingwindows,partitionsshallbeasdescr ibedinthe items of work / drawings.
IS:1948andIS:1949referstoincorporatingthesizes,shapes,thicknessesandwei ghtperrunning metre of extruded sections for various components of the units.However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the Contractor, will be reviewed bythe Engineer and will be accepted onlyif they areequal to or marginallymorethan that given in the codes / specified in the items of work.
Theframeworkofthepartitionswithmullionsandtransomesshallbewithanodise daluminium box sections. Anodised aluminium box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent) as per IS:4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the drawings. Partitions shall be fixed rigidlybetween the floor and the structural columns/beams including provision of necessary shims for wedging etc.
Finishedworkshallbeofrigidconstruction,erectedtrulyplumbtothelinesandlev els,at locations as per the construction drawings.
Specific provisions as stipulated for steel doors, windows, ventilators under clause 8.9.2 shall
alsobeapplicableforthisitemwork.Glazingbeadsshallbeofthesnap-fittypesuitableforthe thickness of glazing proposed as indicated in the items of works.A layer of clear transparent

lacquershallbeappliedonaluminiumsectionstoprotectthemfromdamagedurin
ginstallation. This lacquer coating shall be removed after the installation is
completed.

Measurement

Measurementshallbeinsq.mcorrecttotwoplacesofdecimal.Measurementshall befromout of the frames.Rate quoted shall be for the works including glazing, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

SteelRollingShutters

Materialsand Workmanship

Rollingshuttersshallbeofanapprovedmanufacture,conformingtotherequirem entsspecified in IS: 6248.
The type of rolling shutter shall be self coiling type (manual) for clear areas upto 12 sq.m, gear operated type (mechanical) for clear areas upto 35 sq.m and electrically operated type for areas upto50sq.m.Mechanicaltypeofrollingshuttersshallbesuitableforoperationfro mbothinside and outside with the crank handle or chain gear operating mechanism duly considering the sizeof wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.
Rollingshuttersshallbesupplieddulyconsideringthetype,specifiedclearwidth/ heightofthe opening and the location of fixing as indicated in the drawings.
Shuttersshallbebuiltupofinterlockinglaths75mmwidthbetweenrollingcentresfo rmedfrom coldrolledsteelstrips.Thethicknessofthesteelstripshallnotbelessthan0.90mmfo rshutters upto 3.50m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.
Theguidechannelsoutofmildsteelsheetsofthicknessnotlessthan3.15mmshall beofeither rolled,pressedorbuiltupconstruction.Thechannelshallbeofsizeasstipulatedin IS:6248for various clear widths of the shutters.
Hood covers shall be of mild steel sheets not less than 0.90 mm thick and of approved shape.
Rollingshuttersshallbeprovidedwithacentralhaspandstaplesafetydeviceinad ditiontoone pair of lever locks and sliding locks at the ends.
Allcomponentpartsofthesteelrollingshutter(exceptingspringsandinsidesofguid echannels) shall be provided with one coat of zinc chrome primer conformityto IS:2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective items of work.
In case of galvanized rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanised with a zinc coating containing notlessthan97.5percentpurezinc.Theweightofthezinccoatingpersq.mshallbe asspecified in the items of work.
Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidlyfixedwithnecessaryboltsandholdfasts.Workmanshipoferectionshallens urestrength and rigidity of rolling shutter for trouble free and smooth operation.

Measurement

Measurementshallbeinsq.mcorrecttotwoplacesofdecimaloftheclearareaoftheopening. Quoted rate shall be inclusive of painting as specified in the item of work.

RubbleSub-Base

Materials

Stonesusedforrubblepackingunderfloorsongrade,foundationsetc.,shall beclean,hard, durablerockfreefromveins,flaws,laminations,weatheringandotherdefects.Stonesshall generally conform to the requirements stipulated in IS: 1597 (Part I). Stonesshallbeasregularascanbeobtainedfromquarries.Stonesshallbeofheightequaltothe thickness of the packing proposed with a tolerance of± 10 mm. Stones shall not have a base area neither less than 250 sq cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the Engineer.

Workmanship

Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out simultaneouslywiththeplacinginpositionofrubblepackingandshallnotlagbehind.Afterthis, any interstices between the smaller wedged stones shall be infilled with clean hard sand by brooming so as to fill the joints completely. Thelaid rubble packingshall besprinkledwith waterand compacted byusingsuitable rammers.

Measurement

Measurementshallbeinsq.mcorrecttotwoplacesofdecimalforthespecifiedcompacted thickness of rubble sub-base.

BaseConcrete

The thickness and grade of concrete and reinforcement shall be as specified in items of work. Beforeplacingtheblindingconcrete,thesub-baseofrubblepackingshallbeproperlywettedand rammed. Concrete for the base shall then be deposited between the forms, thoroughly tampedand the surface finished level with the top edges of the forms.Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surfaceof thebaseconcrete shall beleft rough to provideadequate bond for thefloorfinish to be provided later.

Measurement

Measurement shall be in sq.m correct to two places of decimal. This work could be either separateorcombinedalongwiththefloorfinishasindicatedintherespectiveitems ofwork.

TerrazzoandPlainCementTiling Work

Materials

Terrazzo tiles and cement tiles shall generallyconform in all respects to standards stipulated in IS:1237.Tilesshallbeofthebestqualitymanufacturedadoptinghydraulicpressureofnotless than 14N/mm^2.

Thetype,quality,size,thicknesscolouretc,ofthetilesforflooring/dado/ skirtingshallbeas specified in the items of work.
The aggregates for terrazzo topping shall consist of marble chips which are hard, sound and dense. Cement to be used shall be either ordinary Portland cement or white cement with or without colouring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble powder by weight. The proportion of cement shall be inclusive of any pigments. For every one part of cement-marble powder binder mix, the proportion of aggregates shall be 1.75 parts by volume,ifthechipsarebetween1mmto6mmand1.50partsbyvolumeifthechipsarebetween 6mm to 25mm.
Theminimum thickness of wearinglayer of terrazzo tiles shall be 5mm fortiles with chips of size varyingfrom 1mm upto 6mm or from 1mm upto 12mm. This shall be6mm fortiles with chips varying from 1mm upto 25mm.
The minimum thickness of wearing layer of cement/coloured cement tiles shall be 5mm. This shall be 6mm for heavy duty tiles. Pigment usedinthewearinglayershallnotexceed10percent oftheweightofcementusedinthemix.

Workmanship

Layingandfinishingoftilesshallconformtotherequirementsofworkmanshipstipulatedin IS:1443.
Tilingworkshallbecommencedonlyafterthedoorandwindowframesarefixedanddplastering of the walls/ ceiling is completed. Wall plastering shall not be carried out upto about 50mm above the level of proposed skirting/dado.
The base concrete shall be finished to a reasonably plane surface about 40 to 45mm below the level of finished floor. Before the tiling work is taken up, the baseconcrete or structural slab shallbecleanedofallloosematerials,mortardroppings,dirt,laitanceetc.usingsteelwirebrush and well wetted without allowing any water pools on the surface.
Alayerof25mmaveragethicknessofcementmortarconsistingofonepartofcemento6parts of sand shall be provided as bedding for the tiles over the base concrete. The thickness of bedding mortar shall not be less than 10mm at any place. The quantityof water to be added for the mortar shall be just adequate to obtain the workability for laying. Sand for the mortar shall conform to IS:2116 and shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles. The bedding shall be allowed to harden for a day before laying of the tiles.
Neat cement slurry using 4.4 kg of cement per sq.m of floor area shall be spread over the hardenedmortarbeddingoversuchan areaatatimeaswouldaccommodateabout20tiles.Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallettillitisproperlybeddedandinlevelwiththeadjoiningtiles.Thejointsshallbe instraight lines and shall normally be 1.5mm wide. On completion of laying of the tiles in a room, all the joints shall becleaned and washed fairlydeep with a stiffbroom/wirebrush to a minimum depth of 5mm. The dayafter the tiles have been laid, the joints shall be filled with cement grout of the same shade as the colour of the matrix of the tile. For this purpose white cement or greycement with or without pigments shall be used. The flooring should

be kept moist and left undisturbed for 7 days for the bedding/joints to set properly. Heavy traffic shall not be allowed on the floor for atleast 14 days after fixing of the tiles.
About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other crackedorbrokentilesshallberemovedandreplacedwithnewtilestoproperlineandlevel.The same procedure shall be followed again after grinding the tiles and all damaged tiles replaced,

properlyjointedandfinishedtomatch.Forthepurposeofensuringthatsuchreplaced tilesmatch withthoselaidearlier,it isnecessarythattheContractorshallprocuresufficientquantityofextra tiles to meet this contingency.
Whereverafulltilecannotbeprovided,tilesshallbecuttosizeandfixed.Floortiles adjoining the wall shall go about 10mm under the plaster, skirting or dado. Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and
skirtingwork,theverticalwallsurfaceshallbethoroughlycleanedandwetted.The reafteritshall be evenly and uniformly covered with 10mm thick backing of 1:4 cement sand mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. Theback of each tile to befixed shall becovered with a thin layer ofneat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet.
Fixing shall be donefromthebottomof
thewallupwards.Thejointsshallbeinstraightlinesandshallnormally be 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & trulyplumb. Tiles for use at the corners shall be suitably cut with bevelled edges to obtain a neat and true joint. After the work has set, hand polishing with carborundum stones shall be done so that the surface matches with the floor finish. Contractor shall note that the unit rate quoted for skirting shall also include for any chipping of the brickwork required to be carried out for this item.
Wallplasteringofthestripleftoutabovethelevelofskirting/
dadoshallbetakenupafterthe tiles are fixed.
Chequeredterrazzotilesforflooringandforstairtreadsshallbedeliveredtositeafterthefirst machine grinding.
Machinegrindingandpolishingshallbecommencedonlyafteralapseof14daysofla ying.The sequence and three numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out all as specified in IS:1443.
Tiles shall be laid to the levels specified. Wherelargeareas areto be tiled the level of the central portion shall be kept 10mm higher than that at the walls to overcome optical illusion of a
depressioninthecentralportion.Localizeddeviationof±3mminany3mlengthisa cceptablein a nominally flat floor.

Measurement

Measurement forfloortilinganddadoshallbeinsq.mcorrecttotwoplacesof decimal.Actual
quantityoftilingworkaslaidshallbemeasuredforpaymentaspertherespectiveitemsofwork after making deductions for openings etc.Measurement for skirting shall be in running metres correct to two places of decimal for the specified height as per the item of work.

In-SituTerrazzoWork

Materials

The requirements of marble aggregates for terrazzo topping shall be as per clause 8.14.1. Cement shall first be mixed with themarble powder in

drystate. Themix thus obtained shall be mixed with the aggregates in the specified proportions. Care shall be taken not to get the materialsintoaheapwhichresultsinthecoarsestchipsfallingtotheedgesandcementworking to the centre at the bottom. Materials shall be kept, as far as possible, in an even layer during mixing. After the materials have been thoroughly mixed in the dry state, water shall be added, just adequate to obtain plastic consistency for the desired workability for laying. The mix shall be used in the works within 30 minutes of the addition of water to the cement.

Workmanship

The thickness, type, quality, size and colour of chips etc. for the in-situ terrazzo finish for flooring/dado/ skirting shall be as specified in the respective items of works.Laying and finishingofin-situworkshallconformtotherequirementsofworkmanshipstipulatedinIS: 2114.

In-situ terrazzo finish shall be laid over hardened concrete base. The finish layer consists of an underlayerandterrazzotopping.Theunderlayershallbeofcementconcreteofmix 1:2:4using 10mmdowngradedcoarseaggregates.Thecombinedthicknessofunderlayerandtoppingshall not be less than 30 mm for flooring and 20mm for dado/skirting work.

The minimum thickness of topping shall be 6mm if chips used are between 1mm to 4mm, 9mmif chips are between 4mm to 7mm and 12mm if chips are between 7mm to 10mm. If chips larger than10mmsizeareused, theminimumthicknessshallbeoneandonethirdthemaximumsizeof chips.

Both the under layer and later thetoppingshall be divided into panels not exceeding2 sq.m for laying so as to reduce the possibility of development of cracks. The longer dimension of any panel shall not exceed 2m. Dividing strips shall be used to separate the panels. When the dividingstripsarenotprovided,thebaysshallbelaidalternately,allowinganintervalofatleast 24 hours between laying adjacent bays.

Dividing strips shall be either of aluminium, brass or other material as indicated in the items of works.Aluminumstripsshouldhaveaprotectivecoatingofbitumen.Thethicknessofthestrips shall be not less than 1.5mm and width not less than 25mm for flooring work.

Concrete base shall be finished to a reasonably plane surface to a level below the finished floor elevation equal to the specified thickness of terrazzo finish. Before spreadingthe underlayer, the base concrete surface shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. andwellwettedwithoutallowinganywaterpoolsonthesurface.Dividing stripsorscreedstrips, if dividing strips are not provided shall be fixed on the base and levelled to the correct height to suit the thickness of the finish.

Just before spreading the underlayer the surface shall be smeared with cement slurryat 2.75 Kg/sq.m. Over this slurry, the underlayer shall be spread and levelled with a screening board. The top surface shall be left rough to provide a good bond for the terrazzo topping.

Terrazzo toppingshall be laid while the underlayer is still plastic and normallybetween 18 to 24 hours after the underlayer is laid. Cement slurry of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. The terrazzo mix shall be laid to a uniform thickness and compacted thoroughly bytampingand with a minimum of troweling.

Straightedgeandsteelfloatsshallbeusedtobringthesurfacetruetotherequiredlevelinsucha manner that the maximum amount of marble chips come up and spread uniformly all over the surface.

Thesurfaceshallbeleftdryforair-curingforaperiodof12to18hours.

Thereafteritshallbe cured by allowing water to stand in pools for a period of not less than 4 days.
Machine grindingand polishing shall be commenced onlyafter a lapse of 7 days from the time ofcompletionoflaying.Thesequenceandfournumbersofmachinegrindingoperations,usage of the type of carborundum stones, filling up of pinholes, wet curing, watering etc shall be carried out all as specified in IS: 2114.

Measurement

Measurementshallbeasperclause 8.14.3.

Shahabad/Tandur/KotaStoneSlab/Graniteflooringwork

Materials

Theslabsshallbeofapprovedselectedquality,hard,sound,denseandhomogenousintexture, free from cracks, decay, weathering and flaws.The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS : 1124.
The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensionsoftilemorethan100mmshallbe±5mm.Thisshallbe±2mmondimensionsless than 100mm.
Slabs shall besupplied to the specified sizewith machine cut edges or finechisel dressed to the full depth.All angles and edges of the slabs shall be true and square, free from any chipping givingaplanesurface.Slabsshallhavethetopsurfacemachinepolished(firstgrinding)before being brought to site.The slabs shall be washed clean before laying.

Workmanship

Thetype,size,thicknessandcolour/shadeetc.oftheslabsforflooring/dado/skirtingshall beas specified in the respective items of work.
Preparationofthe concretebase,layingandcuringshallbe asper clause 8.14.2.
Dado / skirting work shall be as per clause 8.14.2. The thickness of the slabs for dado/skirting workshallnotbemorethan25mm.Slabsshallbesoplacedthattheback surfaceisatadistance of 12mm. If necessary, slabs shall be held in position temporarily by suitable method.After checkingforverticality,thegapshallbefilledandpackedwithcementsandmortarofproportion 1:3.After the mortar has acquired sufficient strength, the temporary arrangement holding the slab shall be removed.
Grindingandpolishingshallbeasperclause8.14.2exceptthatfirstgrindingwithcoarsegrade carborundum shall not be done and cement slurrywith or without pigment shall not be applied before polishing.

Measurement

Measurementshallbeas perclause8.14.3.

CarborundumTileFinish

Materials

Carborundumtilesshallgenerallyconforminallrespectstothestandardsstipulatedin IS:1237 forheavydutytiles.Tilesshallbeofthebestqualitymanufactured adoptinghydraulicpressure of not less than 14 N/mm^2.
Thetoppingshallbeuniformandofthicknessnotlessthan6mm.Thequantityofcarborundum grit shall be not less than 1.35 kg/sq.m used with cement with or without pigment. The carborundum grit shall pass through 1.18mm mesh and shall be retained on 0.60 mm mesh.
Thesize,thickness,colourandplainorchequered etcofthetilesforflooring/skirtingshallbe as specified in the respective items of work.

Workmanship

Requirementsasdetailedforterrazzo/ cementtilefinishunderclause8.14.2shallbeapplicable for carborundum tile flooring.

Measurement

Measurementshallbeas perclause8.14.3.

GlazedTileFinish

Materials

Glazed earthenware tiles shall conform to the requirements of IS: 777. Tiles shall be of thebest qualityfrom anapproved manufacturer.Thetilesshallbeflat,truetoshapeandfreefromflaws suchascrazing,blisters,pinholes,specksorwelts.Edgesandundersideofthetile sshallbefree from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar.
Dimensionaltolerancesshallbeasspecifiedin IS:777.

Workmanship

Thesize,thickness,colour,withorwithoutdesignsetcofthetilesforflooring/ dado/skirting shall be as specified in the respective items of work.
The total thickness of glazed tile finish including the bedding mortar shall be 20 mm in
flooring/dado/skirting.Theminimumthicknessofbeddingmortarshallbe12mm forflooring and 10mm for dado/skirting work.
Thebeddingmortarshallconsistof1partofcementto3partsofsandmixedwithjus tsufficient waterto obtain proper consistencyforlaying. Sand forthe mortarshall conform to IS: 2116 and shall have minimum fineness modulus of 1.5.
Tiles shall be soaked in water for about 10 minutes just before laying.
Where full size tiles
cannotbefixed,tilesshallbecuttotherequiredsizeusingspecialcuttingdevicean dtheedges rubbed smooth to ensure straight and true joints.
Coloredtileswithorwithoutdesignsshallbeuniformandshallbepreferablyprocure dfromthe same batch of manufacture to avoid any differences in the shade.
Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar droppings etc well wetted without allowing any
waterpoolsonthesurface.Thebeddingmortarshallthenbelaidevenlyoverthesur face,tamped to the desired level and allowed to harden for a day. The top surface shall be left rough toprovide a good bond for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.
Neat cement slurryusing 3.3 kg cement per sq.m of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be
donefromthebottomofthewallupwards.Thejointsshallbeinperfectstraightline s andasthin as possible but shall not be more than 1mm wide. The surface shall be checked frequently to ensure correct level/required slope. Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10mm.
Tiles shall not sound hollow when tapped.

All the joints shall be cleaned of grey cement with wire brush to a depth of atleast 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 daysforthebeddingandjointstosetproperly.Thesurfaceshallthenbecleanedusingasuitable detergent, fully washed and wiped dry.

Specialsconsistingofcoves,internalandexternalangles,cornices,beadsand theircornerpieces shall be of thickness not less than the tiles with which they are used.

Measurement

MeasurementshallbeasperClause8.14.3.In-SituCementConcrete Floor Topping

Materials

Themixproportionfortheinsituconcretefloortoppingshallbe1:2.5:3.5(onepartcement:two and half parts sand: three and half parts coarseaggregates)byvolumeunless otherwise specified in the items of work.
Theaggregatesshallconformfortherequirementsof IS:383.
Coarseaggregatesshallhavehighhardnesssurfacetextureandshallconsistofcrushedrockof
granite,basalt,traporquartzite.Theaggregatecrushingvalveshallnotexceed30percent.The grading of the aggregates of size 12.5mm and below shall be as per IS: 2571.
Gradingofthesand shallbewithinthe limitsindicatedinIS: 2571.

Workmanship

Thethicknessofthefloortoppingshallbeasspecifiedintheitemsofwork.Theminimum thickness of the floor topping shall be 25mm.
Preparationofbaseconcrete/
structuralslabbeforelayingthetoppingshallbeasperclause8.13. The surface shall be rough to provide adequate bond for the topping.
Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specificallypermitted bythe Engineer. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and compacting.Themixshallbeusedintheworkwithin30minutesoftheadditionofwaterforits preparation.
Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half times its
breadth.Toppingshallbelaidinalternatepanels,theintermediatepanelsbeingcastafteragap of atleast one day. Construction joints shall be plain vertical butt joints.
Screed strips shall be fixed dividing the area into suitable panels.
Immediatelybefore depositing the concrete topping, neat cement slurryat 2.75 kg/sq.m of area shall be thoroughlybrushed into the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floatedwithwoodenfloat.Thesurfaceshallthenbetestedwithastraightedgeandmason'sspirit level to detect any inequalities and these shall be made good immediately.
Finishing of the surface bytrowelingshall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first trowellingjustsufficienttogivealevelsurfaceshallbecarriedoutavoidingexcessi

vetrowelling atthisstage.Thesurface shallbere-trowelledaftersometime tocloseanyporesandtoscrapoff excess water or laitance, which shall not be trowelled back into the topping. Final trowelling shall be done well before the concrete has become too hard but at a time when considerable pressure is required to make anyimpression on the surface. Sprinkling of dry cement or cement- sand mixture for absorbing moisture shall not be permitted. Immediatelyafterthesurfaceisfinished,itshallbeprotectedsuitablyfromrapidd ryingdueto wind/ sunlight. After the surface has hardened sufficiently to prevent any damage to it, the topping shall be kept continuously moist for a minimum period of 10 days.

Itispreferabletolaythetoppingonhardenedbaseconcrete,asagainstbeinglaidmonolithically withalesserthickness,sinceproperlevelsandslopeswithclosesurfacetolerancesisachievable in practice, owing to its greater thickness. Further, as this would be laid after all other building operations are over, there will be no risk of any damages or discoloration to the floor finish which are difficult to repair satisfactorily.

Measurement

Measurementshallbeinsq.mcorrectuptotwoplacesof decimal.

In-SituGranolithicConcreteFloorTopping

Materialsand Workmanship

Therequirementsofmaterialsandworkmanshipshallbeallasperclause8.19forin-situcement concrete floor topping except that the mix proportion of the concrete shall be 1:1:2 (cement:sand:coarse aggregates) by volume. Theminimum thickness of granolithicfloortoppingon hardened concretebaseshall be40mm.

Measurement

Measurementshallbeinsq.mcorrectuptotwoplacesof decimal.

FloorHardenerTopping

Materials&Workmanship

Floor hardener toppingshall beprovided either as integrallyfinished over thestructural slab/gradeslaborlaidmonolithicallywiththeconcrete/granolithicfloorfinishontopof hardened concrete base.
Floorhardenerofthemetallicornon-metallictypesuitablefortheperformanceofnormal/ medium/ heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as specified in the respective items of work.
For monolithic application with the floor finish/slab the thickness of the layer shall be 15mm. The topping shall be laid within 2 to 3 hours after concrete is laid when it is still plastic but stiffened enough forthe workmen to tread over it byplacingplanks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping.Laitance shall be removedbeforeplacingthetopping.Thetoppingshallbescreenedandthoroughly compactedto the finished level. Trowelling to a smooth finish shall be carried out as per clause 8.19.2. After the surface has hardened sufficiently, it shall be kept continuously moist for atleast 10 days.
The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.
Surfaceshallbepreventedfromanydamagesduetosubsequentbuildingoperationsbycovering with 75 mm thick layer of sand.

Measurement

Measurementshallbeinsq.mcorrecttotwoplacesofdecimal.Thiscouldbeeitherseparateor combined along with the floor finish as indicated in the respective items of work.

PVCSheet/TileFlooring

Materials

PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/tilesconformingto IS:3462orhomogeneousPVCasbestostilesconformingto IS:3461. The surface of the sheets/tiles shall be free from any physical defects such as pores, blisters, cracks etc. which affects the appearance and serviceability. Tiles/ sheets shall meet with the tolerancelimitsindimensionsspecifiedintheIS.Contractorshallsubmitthetestcertificates,if so desired by the Engineer.
Eachtile/ sheetshallbelegiblyandindeliblymarkedwiththenameofthemanufacturerorhis trade mark, IS certificate mark, and batch number.
TheadhesivetobeusedforlayingthePVCflooringshallberubberbasedandofthemakeas recommended and approved by the manufacturer of PVC sheets/tiles.
Thetype,size,colour,plainormottledandthepatternshallbeasspecifiedinthere spective items of work.

Workmanship

PVCfloorcoveringshall beprovidedoveranunderbedofcementconcretefloorfinishoverthe base concrete or structural slab. It is essential that the sub-floor and the underbed are perfectly drybeforelayingthe PVC flooring. This shall be ensured bymethods of testingas stipulated in Appendix-A of IS: 5318.
Thesurfaceoftheunderbedshallhavetrowelledfinishwithoutanyirregularities whichcreates pooradhesion.Surfaceshallbefreeofoilorgreaseandthoroughlycleanedofalldust,dirtand wiped with a dry cloth.
PVCsheets/ tilesshallbebroughttothetemperatureofthearea inwhichtheyaretobelaidby stacking in a suitable manner within or near the laying area for a period of about 24 hours.
Where air-conditioning is installed, the flooring shall not be laid on the underbed until the A/C unitshavebeeninoperationforatleast7days.Duringthisperiod,thetemperaturerangeshallbe between20deg.Cand30deg.Candthisshallbemaintainedduringthelayingoperationsandalso for 48 hours thereafter.
Layout of the PVC flooring shall be marked with guidelines on the underbed and PVC tiles/sheetsshallbefirstlaidfortrial,withoutusingtheadhesive,accordingtothelayout.
Theadhesive shall beapplied byusinganotched trowel to the surfaceof theunderbed and to the backsideofPVCsheets/tiles.Whentheadhesivehassetsufficientlyforlaying,itwill betackyto the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time which can be covered with PVC flooring within the

stipulated time.
PVC sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that there is minimum gap
betweenjoints.Thealignmentshallbecheckedaftereachrowofsheetiscompleted andtrimmed if considered necessary.
Tilesshallbelaidinthesamemannerassheetsandpreferably,commencingfromt hecentreof the area. Tiles should be lowered in position and pressed firmly on to the adhesive with

minimum gap between the joints. Tiles shall not be slided on the surface. Tiles shall be rolled withalightwoodenrollerofabout5kgtoensurefullcontactwiththeunderlay.Workshouldbe constantly checked to ensure that all four edges of adjacent tiles meet accurately.
Anyexcessadhesivewhichmaysqueezeupbetweensheets/ tilesshallbewipedoffimmediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.
Aminimumperiodof24hoursshallbegivenafterlayingforthedevelopmentofproperbondof the adhesive. When the flooringis thus completed, it shall becleaned with a wet cloth soaked in warm soap solution.
Metallicedgestripsshall beusedtoprotecttheedgesofPVCsheets/tileswhichareexposedas in doorways/ stair treads.
HotsealingofjointsbetweenadjacentPVCsheetflooringtopreventcreepingofwaterthrough the joints shall be carried out, using special equipment as per manufacturer's instructions.

Measurement

Measurement shall be in sq.m correct to two places of decimal.The item could be either separateorasacombined itemwiththefloor finishasspecifiedin therespectiveitemsof work.

AcidResistingBrick/TilingWork

Materials

Theceramicunglazedvitreousacidresistingtilesshallconformtotherequirements ofIS:4457. Acid resistant bricks shall conform to the requirements of IS: 4860.
The finished tile/brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile/brick shall be sound, true to shape, flat, free from flaws and any manufacturingdefectsaffectingtheirutility.Toleranceindimensionsshallbewithinthelimits specified in the respective IS.
The tiles/bricks shall be bedded and jointed using chemical resistant mortar of the resin type conformingtoIS:4832(PartII).Methodofusageshallgenerallybeas pertherequirementsof IS: 4443.

Workmanship

Thesizeandthicknessoftiles/sizeandclassofbricksforuseintheflooring/ skirting/dadoshall be as specified in the respective items of work.
Theresinshallhaveviscosityforreadilymixingwiththe fillerbymanual methods.Thefiller shall have graded particles which permit joint thickness of 1.5 mm.
The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be appliedwithacoatofbitumenprimerconformingtoIS:3384.Theprimedsurfaces hallthenbe applied with a uniform coat of bitumen conforming to IS:1580. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

Justadequatequantityofmortarwhichcanbeappliedwithinthepotlifeasspecifiedb ythe manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/Stainless steel/chromium plated tools shall be used for mixing and laying.
For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacentsidesofthetile/brickshallbesmearedwith4to6mmthickmortar.Tile/ brickshallbe pressedintothebedand pushedagainstthefloor andwiththeadjacenttile/brick,untilthejoint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully.Similarprocedureshallbeadoptedfortheworkonwallsbypressingthetile/ brickagainst

thepreparedwallsurfacesandonlyonecourseshallbelaidatatimeuntiltheinitials etting period.
Themortarjointsshallbecuredforaminimumperiodof72hourswith20to25%hydr ochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughlydry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.
Resinmortarsarenormallyselfcuring.Theareatiledshallnotbeputtousebefore4 8hoursin case epoxy, polyester and furane type of resin is used for the mortar. If phenolic or cashewnut shell liquid resin is used for the mortar, the area tiled shall not be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively, if heat treatment is given with infrared lamp.

Measurement

Measurementshallbeinsq.mcorrecttotwoplacesofdecimalforflooring/ dado.Measurement shall be in runningmetres correct to two places of decimal for skirtingof height as specified in the item of work.

HeavyDutyAbrasionResistantFlooring

Thetype, quality, size, thickness, colour,etc., ofthetile forflooringand skirtingworkshall be of the best quality approved by the Engineer.For this purpose, the Contractor shall provide the Engineer with necessary samples for this selection.Tiles shall be hardwearing, resistant to impact, resistant to abrasion, free from slipperiness and also resistant to attack by water, oils and greases.

EpoxyLiningWork

Materials

Theepoxyresinandhardenerformulationforlayingofjointlesslining workinfloor sandwalls of concrete tanks/trenches etc shall be as per the requirements of IS: 9197.
Theepoxycompositionshallhavethechemicalresistancetowithstandthefollowi ngconditions of exposure:

a) Hydrochloricacidupto30%concentration
b) Sodiumhydroxideupto50%concentration
c) Liquidtemperatureupto60deg.C
d) Ultravioletradiation
e) Alternatewettinganddrying

Sandshallconformtogradingzone IIIor IV of IS:383.
The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic
AmineAdductfortheepoxyresin.Thehardenershallreactwithepoxyresin atnormalambient temperature.
Contractorshallfurnishtestcertificatesforsatisfyingtherequirementsoftheepo xyformulation if so directed by the Engineer.

Workmanship

Theminimumthicknessofepoxyliningshallbe4mm.Itisessentialthattheconcre teelements are adequatelydesigned to ensure that water is excluded to

permeate to the surface, over which the epoxy lining is proposed.

Theepoxyliningshallbeofthetroweltypetofacilitateexecutionoftherequiredthickness for satisfactory performance.
The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oilorgreasebysuitablesolvents,wirebrushedtoremoveanydirt/dustandlaitance .Thesurfaces shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plentyof water or dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.
Justadequatequantityofepoxyresinwhich canbeappliedwithinthepotlifeasspecifiedbythe manufacturer shall be prepared at one time for laying and jointing.
RigidPVC/stainlesssteel/ chromiumplatedtoolsshallbeusedforlaying.Trowellingshallbe carried out to obtain uniformly the specified thickness of lining.
Liningshallbeallowedtosetwithoutdisturbanceforaminimumperiodof24hours.The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

Measurement

Measurementshallbeinsq.m correcttotwo placesof decimal.

Water-Proofing

Machine made flat Yelahanka tiles shall be of the size and thickness as specified in the item of work.Tilesshallbesoakedinwaterforatleastonehourbeforelaying.Thetilesshall belaidon amortarbedofcementmortar1:3withanaveragethicknessof25mm.Tilesshallbelaid,open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and to set to plane surface true to slope, using trowel and wooden straight edge. They shall be laid with their longitudinal lines of joints trulyparallel and generallyat right angles to the direction on run-off gradient. Transverse joints in alternate rows shall come directly in line with each other.
Transverse joints in adjacent courses shall break joints by atleast 50 mm.
The joints shall be completelyfilledandflushpointedwithcementmortar1:3mixedwithred-oxide.Curingshall be carried out for a minimum period of seven days.

General

The work shall include waterproofing for the building roofs, terraces, toilets, floor slabs, walls, planters, chajjas, sills and any other areas and at any other locations and situations as directed by the Engineer.

The waterproofing treatment shall be carried out on top of lime concrete (brick bat coba) laid to slope on roof surfaces.The brick bat coba shall be covered as specified below.

The work shall be carried out by an experienced specialist Sub-Contractor who shall be appointed only after prior approval of the Engineer.

ModifiedBituminousMembrane

Modified Bituminous Membrane shall be “SUPER THERMOLAY” 4 mm thick weighing 4 Kg/sqm, manufactured using APP Polymer modified bitumen with a central core of non-woven polyester reinforcement (200 gms/sqm) and with top and bottom layers of thermofusible film (top layer could also be sand finished) made by STP Limited in collaboration with Bitumat Company Limited.“PLYFLEX”of Bitumat Company Limited, Saudi Arabia supplied by STP Limited shall also be acceptable or other equivalent specification.

WaterproofingofRoofswithLimeC

oncrete 8.25.3.1Materials

Brokenbrickcoarseaggregatespreparedfromwell/ overburntbricksshallbewellgradedhaving a maximum size of 25mm and shall generally conform to IS:3068.
Limeshall be class Clime(fatlime) orfactorymadehydrated limeconformingtoIS:712.

8.25.3.2Workmanship

Lime concrete shall be prepared by thoroughly mixing the brick aggregates inclusive of brick dust obtained during breaking with the slaked lime in the proportions of 2 1/2 (two and a half) parts of brick aggregates to 1 part of slaked lime by volume. Water shall be added just adequate to obtain the desired workability for laying. Washing soap and alum shall be dissolved in the watertobeused.Thequantityofthesematerialsrequiredpercumoflimeconcretes hallbe12kg of washing soap and 4kg of alum. Brick aggregates shall be soakedthoroughly in water for a period of not less than six hours before use in the concrete mix. Lime concrete shall be used in the works within 24 hours after mixing.
Theroofsurfaceoverwhichthewater-prooftreatmentistobecarriedoutshallbecleanedofall foreignmatterbywirebrushing,dustingandmadethoroughlydry.Preparationof surfacesshall be as stipulated in IS: 3067.
Theslopeofthefinishedwaterproofingtreatmentshallbenotlessthan1in60foreff icient drainage. This shall be achieved either wholly in the lime concrete layer or otherwise as indicated in the drawings.
Theaveragethicknessoflimeconcrete,slopeand thefinishontopofmachinemadeburntclay flat terracing tiles conforming to IS:2690 (part I) shall be as specified in the items of work.
Cementconcreteflooringtilesinlieuofclayterracingtilesshallbeprovidedifsosp ecifiedin the items of work, duly considering the traffic the terrace will be subjected to.
The minimum compacted thickness of lime concrete layer shall be 75mm and average thickness shallnotbelessthan100mm.Incase,thethicknessismorethan100mm,itshallbelai dinlayers not exceeding 100mm to 125mm.
Layingoflimeconcreteshallbecommencedfromacorneroftheroofandproceede ddiagonally towards centre and other sides duly considering the slopes specified for effectively draining the rain-water towards the downtake points.
Limeconcretefilletforaminimumheightof150mmshallbeprovidedallalongthej unctionof the roof surface with the brick masonry wall/parapet/column projections. These shall then be finished on top with provision of clay terracing tiles/cement concrete tiles.
Afterthe lime concreteis laid it shall beinitiallyrammed with a rammer weighingnot morethan 2Kgandthefinishbroughttotherequiredevennessandslope.Alternatively,bamb oostripsmay be used for the initial ramming. Further consolidation shall be

done using wooden THAPIES withroundededges.The beatingwillnormallyhavetobecarriedonforat leastsevendaysuntil the THAPI makes no impression on the surface and rebounds readily from it when struck.
Specialcareshallbetakentoproperlycompactthelimeconcreteatitsjunctionwit hparapet walls or column projections.
During compaction by hand-beating, the surface shall be sprinkled liberally with lime water (1 partoflimeputtyand3to4partsofwater)andasmallproportionofsugarsolutionfor obtaining improved water-proofing quality of the lime concrete. On completion of beating, the mortar that comes on the top shall be smoothened with a trowel or float, if necessary, with the addition of

sugarsolutionandlimeputty.Thesugarsolutionmaybepreparedin anyoneofthefollowing ways as directed by the Engineer.

a) Bymixingabout3 KgofJaggeryand 1.5KgofBAEL fruitto100litresof water.

b) Bymixingabout600gm ofKADUKAI(thedrynutsshallbebrokentosmallpiecesand allowed to soak in water), 200 gm of jaggery and 40 litres of water for 10 sq.m of work. This solution shall be brewed for about 12 to 24 hours and the resulting liquor decantedand used for the work.

Thelimeconcreteaftercompactionshallbecured for aminimumperiodofsevendaysoruntilit hardens by covering with a thin layer of straw or hessian which shall be kept wet continuously. Machine made flat terracing tiles shall be of the size and thickness as specified. Tiles shall be soaked in water for at least one hour before laying.Bedding for the tiles shall be 12mm thick in cement mortar 1:3. Tiles shall be laid, openjointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and set to planesurface true to slope, using a trowel and wooden straight edge. Theyshall belaid with their longitudinal lines of joints trulyparallel and generally at right angles to the direction of run-off gradient. Transverse joints in alternate rows shall come directlyinlinewitheachother.Transversejointsinadjacentcoursesshallbreakjoi ntsbyatleast 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:2 mixed with waterproofingcompound as per manufacturer's instructions. Curingshall becarried out for a minimum period of seven days.

Finishing on top with cement concrete tiles or in-situ cement concrete floor topping shall be carriedoutinsimilarfashionasdescribedforclaytilesinabovetheparagraph.Tile stobeused shall be supplied after the first machine grinding of the surface.

Measurement

Measurementshallbeinsq.mcorrecttotwoplacesofdecimal.Measurementshall beforthe plan area wherethe treatment is executed.No separate payment shall be madeforthe fillets.

WaterproofingofRoofs/Terracesetc.

WaterproofingofHorizontalSurfaces

Thewaterproofingshallbeappliedas follows:

AcoatofBlownBitumen85/25shallbeappliedattherateof1.45 kg/sq.km

A roll of Modified Bituminous Membrane shall be unrolled over the primed surface and completely bonded to the substrate by pressing down evenly for the full width of the roll using a wooden roller.Torching shall be done, where recommended by the manufacturer and where directed by the Engineer-in-Charge, as the unrolling progresses.

The side overlaps shall be minimum 100 mm whereas the end overlaps shall be minimum 150 mm; both shall be bonded and sealed by flame torching.

Care shall be taken that the membrane is lapped with the treatment along

the vertical surface and roof gutter treatment for at least 500 mm.

The membrane shall be properly overlapped/terminated at all openings, rainwater downtakes etc. to ensure that such junctions do not become sources of leakage.

Topof membrane finallyshall be painted withantiglouse reflective paint.

8.25.5.2WaterproofingofVerticalSurfacesatRoofLevel andGutters The Water proofing shall be applied as described in (a) above.

Modified Bituminous membrane shall be unrolled and bonded to the substrate after applying a coatofbitumenandbypressingdownevenlyforthefull widthoftheroll.Light torchingshall be done to ensure complete bonding.

Themembraneshallbeoverlappedwithtreatmentforthehorizontalsurfacebyatl east500mm. The membrane shall be taken upto a pre-cut chase anchored and sealed.

KhurrasandRainwaterDownPipes

Down pipes shall be isolated from RCC work with 6 mm polyethylene foam fixed with adhesive (Araldite) and sealed with silicone sealant prior to laying membrane.A water proofing flashing composed of one layer of Hessian based self finished felt Type 3 Grade 1 and two layers of aluminiumfoil of 0.075 mm thickness shall be provided.This flashing shall be carried into the down take pipes forat least 150 mm and sealed with hot bitumen.The Contractor shall closely coordinate the work with the agency providing and fixing the rainwater down take pipes.

Testing

The treated area (flat and horizontal only) shall be tested by allowed water to stand on the treated areas to a depth of 150 mm for a minimum period of 72 hours.

The treated area (flat and horizontal) shall have continuous slope towards the rainwater outlets and no water shall pond any where on the surface.

CementPlasteringWork

Materials

Theproportions of thecement mortar for plasteringshall be1:4 (onepart of cement to fourparts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer. If so desired by the Engineer sand shall be screened and washed to meet the Specifications. The mortar thus mixed shall be used as soon as possible preferably within30minutesfromthetimewaterisaddedtocement.Incasethemortarhassti ffeneddueto evaporationof waterthis maybere-temperedbyaddingwateras

requiredtorestoreconsistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

Workmanship

Preparationofsurfacesandapplicationofplasterfinishesshallgenerallyconformto the requirements specified in IS: 1661 and IS: 2402.
Plasteringoperationsshallnotbecommenceduntilinstallationofallfittingsandfixtures suchas door/window panels, pipes, conduits etc. are completed.
All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/stonemasonryrespectivelywithatoolmadeforthepurposewhenthemortarisstillgreen. The masonry surface to be rendered shall be washed with clean water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably byhacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.
Interior plain faced plaster - This plaster shall be laid in a single coat of 13mm thickness. The mortarshallbedashedagainstthepreparedsurfacewithatrowel.Thedashingofthecoatshall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressionstoobtainapermanentbondandfinishedtosmoothsurface.
Interiorplastershallbe carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the Engineer.
PlainFacedCeilingplaster- Thisplastershallbeappliedinasinglecoatof6mmthickness. Application of mortar shall be as stipulated in above paragraph.
Exterior plain faced plaster - This plaster shall be applied in 2 coats.The first coat or the rendering coat shall be approximately 14mm thick.The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened bycross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for atleast two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leavinganevenanduniformsurface.Themortarproportionsforthecoatsshallbeasspecifiedin the respective item of work. The finished plastering work shall be cured for atleast 7 days.
Interior plain faced plaster 20mm thick if specified for uneven faces of brick walls or for random/coursedrubblemasonrywallsshallbeexecutedin2coatssimilartotheprocedure stipulated in above paragraph.
Exterior Sand Faced Plaster- This plaster shall be applied in 2 coats.The first coat shall be approximately14mm thick and the second coat shall be 6mm thick. These coats shall be applied asstipulatedabove.However,onlyapprovedqualitywhitesandshallbeusedforthesecondcoat and for thefinishingwork. Sand for thefinishing work shall be coarse and of even size and shall be dashed against the surface and

sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.
Wherever more than 20mm thick plaster has been specified, which is intended for purposes of providingbeading,bands,etc.thisworkshallbecarriedoutintwoorthreecoatsas directedby the Engineer duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for atleast 7 days.

Inthecaseofpebblefacedfinishplaster,pebblesofapprovedsizeandqualityshallbe dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the Engineer.
Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition.Battensshallbecarefullyremovedaftertheinitialsetofplasterandtheb rokenedges andcornersmadegood.
Allgroovesshallbeuniforminwidthanddepthandshallbetruetothe lines and levels as per the drawings.
Curingofplastershallbestartedassoonastheappliedplasterhashardenedsuffici entlysoasnot to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.
Forwaterproofingplaster,theContractorshallprovidethewater-proofingadmixtureasspecified in manufacturers instruction while preparing the cement mortar.
For external plaster, the plasteringoperations shall be commenced from the top floor and carried downwards.Forinternalplaster,theplasteringoperationsforthewallsshallcom menceatthetop and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.
Doublescaffoldingto be used shallbeasspecifiedinclause8.2.2.
Thefinishedplastersurfaceshallnotshowanydeviationmorethan4mmwhencheck edwitha straight edge of 2m length placed against the surface.
Toovercomethepossibilityofdevelopmentofcracksintheplasteringworkfollowin gmeasures shall be adopted.

a) Plasteringworkshallbedeferredasmuchaspossiblesothatfairlycompletedryin gshrinkagein concrete and masonry works takes place.
b) Steelwirefabricshallbeprovidedatthejunctionofbrickmasonryandconcretet oovercome reasonably the differential drying shrinkage/thermal movement.
c) Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaceswhere discontinuity of the background exists.

Measurement

Measurement for plastering work shall be in sq.m correct to two places of decimal.Unless a separateitemisprovidedforgrooves,mouldings, etc.,theseworksaredeemedtobeincludedin the unit rates quoted for plastering work.The quantityof work to be paid for under these items shall be calculated bytaking the projected surface of the areas plastered after making necessary deductions for openings for doors, windows, fan openings etc.The actual plaster work carried out on jambs/sills of windows, openings, etc. shall be measured for payment.

CementPointing

Materials

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to threepartsoffinesand).SandshallconformtoIS:1542andshallbefreefromclay,shale,loam,alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be

approvedbyEngineerandifsodirecteditshallbewashed/ screenedtomeetspecification requirements.

Workmanship

Where pointing of joints in masonry work is specified, the joints shall be raked at least 15mm/20mmdeepinbrick/stonemasonryrespectivelyastheworkproceedswhent hemortaris still green.
Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth andthejointsshallberaised,flat,sunkor'V'asmaybespecifiedintherespectiveite msofwork. No false joints shall be allowed.
The work shall be kept moist for atleast 7 days after the pointing is completed. Whenever colouredpointinghastobedone,thecolouringpigmentofthecolourrequiredshall beaddedto cement in such proportions as recommended by the manufacturer and as approved by the Engineer.

Measurement

Thequantityofworktobepaidforunderthisitemshallbemeasuredinsq.m.Correc ttotwo places of decimal by taking the projected surface of the area pointed after making necessary deductions for openings, etc.

MetalLathandWireFabric

Materials

WeldedsteelwirefabricshallconformtoIS:4

948. Expanded metal shall conform to IS:

412.

Galvanisedwiremeshshallbeofapproved quality.

Workmanship

The type and details of the steel material to be used for metal lath plastering work and at the junctions of brick masonry/concrete before wall plastering shall be as specified in the respective items of work.

Formetallathplasteringwork,theweightofsteelmaterialshallbenotlessthan1.6 kg/sq.m.

Steelmaterialforuseatthejunctionofbrickmasonry/ concreteshallhavethemeshdimensionsnot greater than 50 mm.

Steel material shall be obtained in maximum lengths as manufactured to restrict joints to the minimum. Overlap at the joints shall be minimum 25 mm which shall be securely tied with wires of diameter notless than 1.25 mm at spacings not more than 100 mm for lath plastering work.Nailing to wall shall be at spacings not

exceeding 200 mm.The material shall be straightened, cut and bent to shape if required for fixing as per the details indicated in the drawings.

Measurement

Measurement shall be in sq.m correct to two places of decimal for the type as specified in the respective items of work.

Water-ProofingAdmixtures

Water-proofing admixture shall conform to the requirements of IS: 2645 and shall be of approvedmanufacture.Theadmixtureshallnotcontaincalciumchloride.Thequantityofthe admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the Engineer.

PaintingofConcrete,Masonry&PlasteredSurfaces

Materials

OilbounddistempershallconformtoIS:428.Theprimershallbealkaliresistantprimerofthe same manufacture as that of the distemper.
CementpaintshallconformtoIS:5410.Theprimershallbeathinnedcoatofcementpaint. Lead free acid, alkali and chlorine resisting paint shall conform to IS: 9862.
Whitewashshallbemadefrom goodqualityfatlimeconformingto IS:712.Itshallbeslakedat site and mixed with water in the proportion of 5 litres of water to 1 kg of unslaked lime stirred well to make a thin cream.This shall be allowed to stand for a minimum period of one day and strained through a clean coarse cloth.Four kg of gum dissolved in hot water shall be added to eachcumofcream.1.30kgofsodiumchloridedissolvedinhotwatershall thenbeaddedper10 kg of lime used for the white wash to be ready for application.
Colourwashshallbemadebyadditionofasuitablequantityofmineralpigment,notaffectedby lime, to the prepared white wash to obtain the shade/tint as approved by the Engineer.
Allthematerialsshallbeofthebestqualityfromanapprovedmanufacturer.Contractorshall obtain prior approval of the Engineer for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

Workmanship

ContractorshallobtaintheapprovaloftheEngineerregardingthereadinessofthesurfacesto receive the specified finish, before commencing the work on painting.
Paintingofnewsurfacesshallbedeferredasmuchaspossibletoallowforthoroughdryingof the sub- strata.
The surfaces to be treated shall be prepared bythoroughlybrushingthem free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence.Effloresencesshallberemovedonlybydrybrushingofthegrowth. Cracksshall be filled with Gypsum. Workmanship of painting shall generally conform to IS: 2395.

Surfacesofdoors,windowsetc.shallbeprotectedsuitablytopreventpaintfinishesfrom splashing on them.

WhiteWash

Thepreparedsurfacesshallbewettedandthefinishappliedbybrushing.Theoperationforeach coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is

applied.Minimumof2coatsshallbeappliedunlessotherwisespecified.Thedrysurfaceshall present a uniform finish without any brush marks.

ColourWash

Colourwashshallbeappliedinthesamewayas forwhitewash.Aminimumof2coatsshallbe applied unless otherwise specified. The surface shall present a smooth and uniform finish without any streaks. The finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed.

CementPaint

Thepreparedsurfacesshallbewettedtocontrolsurfacesuctionandtoprovidemoisturetoaidin proper curing of the paint. Cement paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacturer's instructions. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water proofing in addition to decoration. Cement paint shall be brushed in uniform thickness and the covering capacityfortwocoatsonplasteredsurfacesshallbe3to4kg/sq.m.Aminimumof2coatsofthe same colour shall be applied. Atleast 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for atleast 2 days after theapplication of final coat. Theoperations forbrushingeach coat shall beas detailed above.

Oilbound Distemper

The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing.Thesurfaceshallbefinisheduniformlywithoutleavinganybrushmarksandallowed to dry for atleast 48 hours. A minimum of two coats of oil bound distemper shall be applied, unless otherwise specified. The first coat shall be of a lighter tint. Atleast 24 hours shall be left after the first coat to become completely dry before the application of the second coat. Broad, stiff, double bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed above.

Acid,AlkaliResistingPaint

Aminimumof2coatsofacid/ alkaliresistingpaintshallbeappliedoverthepreparedry surfaces by brushing. Primer coat shall be as per manufacturer's instructions.

PlasticEmulsionPaint

The prepared surface shall be dryand provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instructions. The paintshallbelaidonevenlyandsmoothlybymeansofcrossingandlayingoff.Thecrossingand laying off consists of covering the area with paint, brushing the surface hard for the first time over and then brushing alternately in

opposite directions two or three times and then finally brushing lightly in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally takes about 2 to 3 hours. A minimum of 2 finishing coats of the same colour shall be

applied unless otherwise specified. Paint may also be applied using rollers. The surface on finishingshallpresentaflatvelvetysmoothfinishanduniforminshadewithoutanypatches.

AcrylicEmulsionPaint

Acrylic emulsion paint shall be applied in the same wayas for plastic emulsion paint. A minimumof2finishingcoatsoveronecoatofprimershallbeprovidedunlessotherwise specified.

Measurement

Measurement shall be in sq.m correct to two places of decimal.Measurement shall be for the areasasexecuteddulydeductingforanyopeningsetc.Ratequotedshalltakeintoaccountthe provision of necessary enabling works such as scaffolding, painter's cradle etc.

Painting&PolishingofWoodWork

Materials

WoodprimershallconformtoIS:3536. Filler shall conform to IS:110.
Varnish shall conform to IS:337.
FrenchpolishshallconformtoIS:348.
Syntheticenamelpaintshallconformto IS: 2932.
Allthematerialsshallbeofthebestqualityfromanapprovedmanufacturer.Contractorshall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

Workmanship

Thetypeoffinishtobeprovidedforwoodworkofpaintingorpolishing,thenumberofcoats, etc. shall be as specified in the respective items of work to be prepared by the Contractor.
Primerandfinishpaintshallbecompatiblewitheachothertoavoidcrackingandwrinkling. Primer and finish paint shall be from the same manufacturer.
Painting shall be either by brushing or spraying. Contractor shall procure the appropriate quality ofpaintforthispurposeasrecommendedbythemanufacturer.Theworkmanshipshallgenerally conform to the requirements of IS: 2338 (Part I).
All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter.
Surfacesshallbesmoothenedwithabrasivepaperusingitacrossthegrainsanddustedoff.Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of work to be prepared by the Contractor. Any slight irregularities of the surface shall then be made- up by applying an optimum coat of filler conforming to IS: 110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of

synthetic enamel paint conforming to IS:2932. Paint shall be applied by brushing evenly and smoothlybymeansofcrossingandlayingoffinthedirectionofthegrain ofwood.Afterdrying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. Atleast 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Employer’s Representative. The number of coats of paint to be applied shall be as specified in the item of work to be prepared by the Contractor.
All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it in the direction of thegrainsanddustedoff.Anyslightirregularitiesofthesurfaceshallbemadeupby applyingan

optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnishconformingtoIS:337shallbeappliedbybrushing.Varnishshouldnotberet ouchedonce it has begun to set. Staining if required shall be provided as directed by the Employer's Representative. When two coats of varnish is specified, the first coat should be a hard-drying undercoat or flatting varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as specified. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish using a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles to give an even finish over the entire area.
Thesurfaceshallbeallowedtodrybeforeapplyingthenextcoat.Finishingshallbe carriedout using a fresh clean cloth over the pad, slight dampening with methylated spirit and rubbing lightly and quickly in circular motions. The finished surface shall have a uniform texture and high gloss. The number of coats to be applied shall be as specified.

PaintingofSteel Work

Materials

Red-oxide–
zincchromeprimershallconformtoIS:2074.
Synthetic enamel paint shall conform to IS: 2932.
Aluminiumpaintshallconformto IS: 2339.
Allthematerialsshallbeofthebestqualityfromanapprovedmanufacturer.Contrac torshall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/shade.All the materials shall be brought to the site in sealed containers.

Workmanship

Painting work shall be carried out only on thoroughly dry surfaces.Painting shall be applied either by brushing or by spraying.Contractor shall procure the appropriate quality of paint for
thispurposeasrecommendedbythemanufacturer.Theworkmanshipshallgener allyconformto the requirement of IS: 1477 (Part 2).
The type of paint, number of coats etc. shall be as specified in the respective items of work.
Primerandfinishpaintshallbecompatiblewitheachothertoavoidcrackingandwr inkling. Primer and finish paint shall be from the same manufacturer.
Allthesurfacesshallbethoroughlycleanedofoil,grease,dirt,rustandscale.Them ethodstobe adoptedusingsolvents,wirebrushing,powertoolcleaningetc.,shall beasperIS:1477(Part–I) and as indicated in the item of work.
It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a
continuousfilmwithoutholidays.Afterthefirstcoatbecomesharddry,asecondco atofprimer shall be applied by brushing to obtain a film free from `holidays'.
Afterthesecondcoatofprimerisharddry,theentiresurfaceshallbewetrubbedcu

tting down
toasmoothuniformsurface.Whenthesurfacebecomesdry,theundercoatofsynt
heticenamel paint of optimum thickness shall be applied by brushing with minimum of brush marks.The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed.The surface shall then be allowed to dry.
Thefirstfinishingcoatofpaintshallbeappliedbybrushingandallowedtohard-dry.Thegloss from the entire surface shall then be gently removed and the surface dusted off.The second finishing coat shall then be applied by brushing.

Atleast24hoursshallelapsebetweentheapplicationofsuccessivecoats.Eachcoats hallvary slightly in shade and this shall be got approved by the Employer's Representative.

Flashing

1.64.1Materials

AnodisedAluminiumsheetsshallbe1.00mmthickwithanodicfilmthicknessof0.02 5mm. Galvanised mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/sq.m.
BitumenfeltshallbeeitherHessianbaseselffinishedbitumenfeltType-3Grade Iconformingto IS:1322 or glass fibre base self finished felt Type-2 Grade 1 conforming to IS:7193.

Workmanship

Thetypeof theflashing and method offixing shall beas specified.
Flashingshallbeofthecorrectshapeandsizeasindicatedintheconstructiondrawin gsandthey shall be properly fixed to ensure their effectiveness.
Flashingshallbeoflonglengthssoastoprovideminimumnumberofjoints.Themin imum overlap at joints shall be 100mm.
Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide x 65 mm deep in masonry/concrete along with cement mortar 1:4 filletting
asindicatedintheDrawings.Curingofthemortarshallbecarriedoutforaminimu mperiodof4 days.
Bitumenfeltflashingofthetypeasspecifiedshall beprovidedwith2coatsofbituminouspaint at the rate of 0.10 litre/sq.m after the installation.

Measurement

Measurement shall be in sq.m correct to two places of decimal.Measurement shall be for the actualareaoftheflashingmaterialprovidedandtherateshallincludeforalltheinci dentalworks of bending to shape and fixing details as per the construction drawings.

ThermalInsulationforCeiling

Thermalinsulationshallbe"Thermocole"TFtypeorsimilarapprovedorResinbon dedfibre glass boards.

Fixing

"Thermocole"Boards

SoffitofR.C.slabshallbethoroughlycleanedwithwirebrushand85/25industrialg radehot bitumen conforming to IS: 702 shall be applied uniformly over the surface at the rate of 1.5 Kg/m^2.
Thermocoleboards(T.F.variety)of50mmthicknessshallbestuckbymeansofthes amegrade of hot bitumen.
Theboardsshallbefurthersecuredwithscrews,washersan dplugs. The joints of the boards shall be sealed with bitumen.

FibreGlassBoards

Timberpegs50mmx50mmx50mmshallbefixedtotheslabat600mmcentreswith6 mmx 65mm long wood screws.20 gauge G.I. lacing wire shall be tied to the pegs.

`Crown’200fiberglassboards50mmthickshallbestucktothepegswithCPRXcompoundor any other suitable adhesive and be held in position by the 20 gauge G.I. lacing wires.
The insulation boards shall be covered with 20mm – 24 gauge hexagonal G.I. chicken wire mesh,nailedtothetimberpegsand30gaugealuminiumsheetsshallbefixedovert hechicken wire mesh with 50mm overlap and secured to the timer pegs by screws.
Iftheinsulationisspecifiedtorestontopofthefalseceiling,itshallbe properlyinstalledand anchored to the framework.In case additional battens are required for proper installation, Contractor shall include its cost in the rate for insulation.

Measurement

Thenet superficialareaoftheinsulationshall bemeasuredandpaid for.

PlasterofParisBoardFalse Ceiling

PlasterofParisBoards

Theplasterofparisboardstobeusedinthefalseceilingshallbeofan approvedmanufactureor manufactured at site by methods and materials approved by Engineer.
The plaster of paris shall be of the calcium-sulphate hemi-hydrate variety and shall contain not less than 35 percent sulphurtrioxide and otherrequirements as per IS:2547 (Part I)However, its finenessshallbesuchthattheresidue,afterdrying,andsievingon I.S. sievedesignation3.35mm for 5 minutes shall not be more than 1 percent by weight.Initial setting time shall not be less than 13 minutes.The average compressive strength of plaster determined by testing 5 cm cubes 24 hours after removal from moulds and drying in an oven at 40 Deg. C till the weight of the cubes is constant, shall not be less than 84 kg per sq.cm.
The plaster of paris boards reinforced with hessian cloth or coir shall be prepared in suitable sizesasshownonthedrawingsorasdirectedbytheEngineer.Woodenformsofhei ghtequalto the thickness of boards shall be placed on truly level and smooth surface such as a glass sheet.
The edges of the boards shall be truly square.The glass sheet or surface on which form is kept and the form sides shall be given a thin coat of non-staining oil to facilitate the easyremoval of the board.Plaster of paris shall be evenly spread into the form upto about half the depth and hessian cloth or coir shall bepressed over theplaster ofparis layer.Theweight of hessian cloth or coir in the board shall be 250 gm per sq.m.The ends of the hessian/coir reinforcement shall be turned over at all edges to form a double layer for a width of 50mm.The hessian cloth shall beofanopenwebtexturesoastoallowtheplasterbelowandabovetointermixwith eachother and form an integral board.The form shall then be filled with plaster ofparis which shall be uniform pressed and then wire cut to an even and smooth surface.The board shall then be allowedtosetinitiallyforanhourorso andthenremovedfromtheformandallowedtodryand harden for about a week.Theboard after dryingand hardeningshall give a ringingsound when

struck.The boards shall be true and exact to shape and size and the exposed face shall be truly plane and smooth.
Thesizeofboardsshall generallybe600mmx 600mmx 12mmthick.Boardsshallbekeptdry in transit and stored flat in a clean dry place and shall not be exposed to moisture.The boards shall always be carried on edges.

MetalFramework

Themetalframeworkmaybemadeofsectionsoflightmetal,suchas anodisedaluminium,mild steel or as shown on the drawings.The shape of cross-section shall be such as to facilitate

propersuspensionandproperfixingoftheceilingboardscoveringthemandshallbe structurally sound and rigid.

Construction

Contractor shall ensure that the frame to support the ceiling is designed for structural strength andthesizes,weight and strengthofceilingboardstobefixedandotherloadsduetoliveload, air-conditioning ducts, grills, electrical wiring and lighting fixtures, thermal insulation, etc. as shownonthedrawings.Contractorshallalsosubmitadetaileddrawingtoshowth egridwork, sizes of grid members, method of suspension, position of openings for air-conditioning and lighting, access doors, etc.

The false ceiling grid work shall be carried out as per the approved drawings or as directed by Engineer.In case of timber grid work, the grid work shall consist of teak wood runners of minimum size 60mm deep x 40mm wide along one direction at 1.2m centre to centre and secondaryrunnersofsize50mmdeepx40mmwideat60mmcentretocentreperpe ndicularto the main runners.

The metal frame work when it is anodised aluminium false ceiling grid system shall consist of aluminiummainmemberofspecialT-Profileof38mmx38mmx1.5mmthick,interlockingwith each other to form frames of various sizes, 600mm x 600 mm or as shown on the drawing.The main members shall be suspended from the roof structures by means of steel hangers asdescribed for timber frame work and supported at the walls by means of anodised aluminium wall angles.

In the case of timber frame work, all the edges of the plaster of paris board shall be fixed to frame members bymeans of counter sunk and rustless screws of 2.74 mm size, 40mm long at a spacingof100mmto150mmc/cand12mmfromtheedgeoftheboard.Holesforscr ewsshall bedrilledandscrewsslightlycountersunkintotheboards.Theboardsshall befixedtowooden framework with a joint clearance of about 3mm.The joints shall always be in perfect line and plane.

Incaseofaluminiumgridsystem,boardsshallbejustplacedintotheframesformedb ythe main `T' members and the cross members fitted with the clips for locking boards.Contractor shall take utmost care so as not to force the boards in position and a slight gap shall be provided so as not to make a tight joint.The boards shall be cut with a saw, if required, to any shape and size.

As the work of false ceiling may be inter-connected with the work of air-conditioning ducts and lighting,Contractorshall fullyco-operatewiththe otheragenciesentrusted withtheabovework, who may be working simultaneously. Contractor shall provide necessary openings in the false ceilingworkforair-conditioning,lightingandotherfixtures.Additionalframing,ifrequired,for theaboveopeningshallalsobeprovidedatnoextracosttotheEmployer.Removabl eorhinged type inspection or access trap doors shall be provided at locations specified by the Engineer.

Finishing

Itisessentialthatfalseceilingworkshouldbefirmandinperfectlineandlevelandall boards free fromdistortion,bulge,andotherdefects.Alldefectiveboardsandothermaterials hallbe removed from site immediately and replaced, and ceiling restored to original finish to the satisfaction of Engineer.

Theworkmanshipshallbeofhighestorderandall joineryworkfortimber workshallbeinthe bestworkmanshipmanner.Thejointsforaluminiumframeworkshallbeofinter-lockingtype so that when the cross member is in place, it cannot be lifted out.

The countersunk heads of screws and all joints shall be filled with plaster of paris and finished smooth.Afterfillingthejoints,athickskinofthefinishingmaterialshallbespreadabout50mm wide on either side of the joint and on to it shall betrowelled drya reinforcing scrim cloth about 10mm wide.If metal scrim is used, a stiffer plaster will be necessaryto enable the trowelling of the scrim down to the board.

Fire Stopping

In case of fire protective ceilings, fire resisting barriers at suitable intervals shall be provided. These shall completelyclose the gap between the false ceilingand soffit of the structural slab. The material of the barrier shall be as indicated by Engineer (Reference may be made to the BritishStandardsInstitutionsCP290:CodeofPracticeforsuspendedceilingandlining ofdry construction using metal fixing system, `for guidance).

MeasurementandPayment

The superficial area of false ceiling shall be measured and paid for at the unit rate less deductions,ifany.Openingsinfalseceilingwhicharelessthan0.4sq.m.inareashallnotbe deducted for the purpose of payment.
The quoted rates shall include supply, delivery and erection of all materials for covering the ceiling, frame work suspenders or hangers, anti-termite treatment making openings in false ceiling,extraframeworkrequiredfortheopenings, supportingthemainmembersonmasonry walls, levelling and finishing complete.
Wheremouldingorbeadingisspecified,itshallbeasperdetailsshownindrawingsandshallbe measured in running metres and paid for separately.
Wherefirebarriersarespecified,theyshallbeasperdetailsshownindrawingsand asdirected and shall be measured in square metres and paid for separately.

FalseorCavity Floor

FrameWork

The false floor shall consist of a framework of suitable structural member designed to carry the loads specified.This frame work shall be supported on suitably designed stools placed at 600mmcentretocentreinbothdirections.Thestoolsshallconsistofamildsteelbaseplatewith a mild steel stud having adjustable lock nut and coupling at the centre and another mild steel plate at top serving as a prophead.The above framework shall be suitably designed to accommodate35mmthick,600mmsquarepanels.Thebaseplateshallbefixedtothereinforced concrete floor with an approved adhesive compound or with 4 Nos. 6mm dia.anchor fasteners. Bedding of 1:2 or richer cement sand mortar shall be provided locally under the base plates of stools to provide a level surface.
The prophead shall be provided with mild steel lugs welded on top and each placed perpendicular to the other for proper positioning and supporting the main and cross members.
Thestoolsshallbecapableofadjustmenttoaccommodateconcretefloorlevelirreg

ularitiesupto plus or minus 15mm.The framing members shall be completely removable and shall remain in positionwithoutscrewingorboltingtothepropheads.Allsteelframeworkincludingsteelstools shall be given a coat of zinc chromate primer and two coats of enamel paint of approved colour and shade.

FloorPanels

Thefloorpanelsshallbemadeof600mmx600mmx35mmthickmediumdensityunveneered/ non-prelaminated teak wood particle boards having a density of not more than 800 kg/cum bonded with boiling water proof phenol formaldehyde synthetic resin and shall be of fire resistant, termite resistant and moisture proof quality, generally conforming to IS: 3087- specification for wood particle boards (Medium Density) for general purposes.
Thethermal conductivityof theboardsshall not exceed 0.12 k Cal/hr/sq.m/deg./C/m.
Thepanelsizegivenabovemaybesuitablymodifiednearelectricalpanel/ equipmentandalsoto suit room dimensions with panel size not more than 600mm under anycircumstances.Exposed 2mm thick vinyl edgingshall be provided on all edges of individual panels.Each panel shall be given a coat or primer and two coats of approved fire resistant paint from underside.
The particle boards shall be faced with 600mm x 600 mm x 2mm thick approved make flooring tiles conforming to IS:3462 and of approved colour and shade.The completed panel shall be completelyremovableandshallremaininpositionwithoutscrewingorboltingtothesupporting framework.Each floor panel shall be marked on the inner side with stickers for easy identification and reassembly whenever required.
Suitablebackingmaterialshallbeprovidedontheundersideoftheparticleboardto prevent warping and / or to cater to specified loading.
Suitableremovablecoversshall beprovided toserveasoutlets forthecables.

FinishedHeightofFalseFlooring

Thefinishedheightfromtopofreinforcedconcretefloortothefinishedfloorsurfaceof false/cavity floor shall be as specified or as shown on drawings.

RampsandSteps

Rampsandstepsshallbeprovidedasshownon theEngineer’sdrawingandasdirectedbythe Engineer without any extra cost to the Employer.

Imposed Loading

Thefinishedfloorshallbecapableofsupportinguniformlydistributedloadsof500 to1000Kg. per sq.metre of floor area as specified in data sheet.A point load of 450 Kg on 600 sq.mm on any part of the panel or a line load of 725 Kg on 100mm strip across the panel length shall not result in a deflection greater than 2.5mm.

Finish

Thefinishedfloor shallbetrueto linesand levelsand presentaneatflush surface.

General

Supply shall be made by a specialist supplier who is to be approved by Engineer. Supplier shall prepareandsubmitalayoutdrawingforfalsefloorgivingalldetailsincludingsupportingsystem for approval.If so called for, supplier shall also submit his calculations for the supporting system with all relevant data assumed, to the Engineer for his approval.Work shall be carried out on approved drawings only.

Measurement

Thesuperficial areaoffalsefloor shallbemeasuredandpaidforatthequotedunit rate.

VendorDrawing

Vendor shall prepare and submit a layout drawing for false floor giving all details including supportingsystemforapproval.Ifsocalledfor,vendorshallalsosubmithiscalculations forthe supporting system with all relevant data assumed, to the Employer’s Representative for his approval.Work shall be carried out on approved drawings only.

FireProofDoors

MaterialandWorkmanship

The design of fire proof doors and the materials to be used in their fabrication have to be such that they shall be capable of providing the effective barrier to the spread of fire.The materials, fabrication and erection of fire proof doors shall confirm to IS: 3614 (Part – I).The fire proof doors shall be obtained from an approved manufacturer.Specific approval for such purchase shall be obtained before hand. Sample approval shall also be obtained from testing authority as per the standard IS: 3614 (Part– 2) for the specified degree of fire rating in hours.All fire proof doors shall have specified sizes and confirm to the description in the respective items of work.

Fire proof door shutters shall be of zinc coated weldable steel (confirming to BS: 6687) or stainless steel (conforming to IS: 304) sheet (18G minimum) fixed in a frame work of rolled channel.The shutter shall consist of aninsulating materiallike mineral woolin requiredthickness to satisfythe specifiedfire rating. Normallythethickness ofdoorshuttershallnot belessthan 35mmfortwohourfireratingand 46 mmfor four hour fire rating.

Theshutterwiththerequiredinsulatingmaterialshallbemountedonangleironframeorthespecialmade frame from zinc coated (16G minimum) weldable steel sheet.The shutter shall be fixed to frame by means of suitable hinges and shall have a three waylatchingsystem.All the doors shall be provided with a coat of primer and one coat of synthetic enamel paint to attain the specified fire rating.All other accessories like hinges, door lock, hold fasts, etc. shallbe provided as approved by TAC(Tariff Advisory Committee).All these accessories shall be compatible with the material used for door and shutter.

Handrail

All hand railing shall be provided with Aluminum Extrusion tubes having alloy AA6082 Temper T6 or AA6063T6withanultimatetensilestrengthofatleast207MPaandyieldstrengthofatleast172MPa. The minimum height of hand railing shall be 1m and maximum spacing of verticals shall be 1.5 m- Number of horizontal rails shall be 3 with a 100mm x 2.5mm toe plate at the bottom.

TopRail shall befrom32NB(42.16mmOD)tubeofschedule40(3.50mmthk),while2noofmidrail shall

be of 25NB (33.4mm OD) Schedule 40 tube. Post tube shall be 32NB (42.16mmOD) Schedule 80 (4.80mmthk min). Toe guard of min 100mmheight & having sufficient rigidity extruded out of min 2.5mmThkalloyAA6063TemperT6.

welding not allowed for fabrication of handrails. Assembly and fabrication of Handrail shall be done by usingStructuralFittings,manufacturedfromAluminiumAlloy356/LM25withheattreatment(minUTS of alloy -280 N/mm2) confirming to ASTM B 108, ASTM B 26/ BS 1490. Aluminium Structural fittings shall be dynamicallytestedfor permissible deflectionswhile applying 74 kg/ Linear Meter of UDL & 90 kg point load as per methodology mentioned in ASTM E 935.

HandrailshallbefixedonRCCsurfacewithMechanicalorChemicalAnchorfastenersand shallbeofSS or HDGand allfittings andpipes shall be prefinished as per IS 1868.Thedrawings to be submittedtothe engineer for approval.

EndofSection-8

SECTION9

WELLSINKING

SECTION9

WELLSINKING

General

WellsinkingshallbeproposedforWetwell,inwaterloggedconditionsorwatertablenearFGL.

EarthworkinExcavation

Theearthworkshall beinaccordancewithSection3.Thesafetymeasurestobetakenforexcavations for open foundations shall be as per guidance laid down in IS 3764.

WellSinking

TheConstructionandsinkingofwell shallingeneralfollowprovisionsofIRC78-2014-SectionVII– Foundations and substructure.The latest editions of this code of practice including all applicable official amendments and revision shall be followed.In case of discrepancybetween this specification and that referred in code, the specifications will govern.

Setting Out

Necessary reference points shall be fixed, away from the zone of blow-ups or possible settlements resultingfromwellsinkingoperations.Thesereferencepoints shallbeconnectedtothepermanent stations with the base line on the banks.The centre of the individual wells shall be marked with reference to these stations.

Equipment

Thefollowingequipmentsaregenerallyusedforthe work

(a) Cranewithgrabbuckets-capacity0.5to2.0cum
(b) Chiselsofappropriatesizes

(c) Aquaheaderforcuttingrockystrata
(d) Divinghelmetsand accessories
(e) Equipmentforconcreteproduction,transportation,placing&compaction

Cutting Edge

The mild steel cutting edge shall be made from structural steel section with weight not less than 40 kg/m length and properly anchored into the well curb.The parts of cutting edge shall be erected on level firm ground.Temporary support shall be provided to facilitate erection and maintaining the assembly in true shape.The fabrication may be carried out in the shop or at site.Steel sections shall not be heated and forced into shape.However “V” cuts may be made in the horizontal portion, uniformly throughout the length, to facilitate cold bending.After bending such ‘V’ cuts should be closedbywelding.Jointsinthelengthsofstructuralsections,unlessotherwisespecifiedshallbefillet welded using single cover plate to ensure the requisite strength of the original section.The cutting edge must be suitably stiffened using plate stiffeners spaced at not more than 1.5m c/c along the periphery of cutting edge. The adequacy of the strength and the efficiency of performance of cutting edge shall bespecificallychecked by Contractor and necessaryalterations made ifrequired at his own responsibility. The weight of stiffeners shall not be considered in weight of cutting edge.

WellCurb

Well curb shall be of cast-in-situ concrete.The outer face of the curb shall be vertical.The bottom ends of vertical bond rods of steining shall be fixed securely to the cutting edge with check nuts or by welds.Theformworkonouterfaceofcurbmayberemovedwithin24hrsafterconcreting.Theform work of inner face shall be removed after 72 hrs.All the concreting in the well curb shall be done in one continuous operation. The curbs should be cast truly in position and if construction of any cofferdam is required, it shall be done by the Contractor at his own cost.

WellSteining

Thedimensions,shape,concretestrengthandreinforcementsofthewellshallstrictlyconformtothose shown in the drawings.The form work shall preferably be of M.S. sheets shaped and stiffened suitably.In case timber forms are used, they shall be lined with plywood or M.S. sheets.

Steining built in the first lift above the well curb shall not be more than 2 meters.For stability, the first lift of steining shall be cast only after sinking the curb partially.Concreting of steining may be carriedoutinsubsequentliftsofabout2meters.Attemptsshouldbemadetominimisethenumberof construction joints.The construction joints details shall be as shown in drawing and the receiving

surfacesofconstructionjointshallthoroughlybe cleanedandpreparedusingairandwaterjetsbefore the next lift is poured. Theconcreting layers shall be limited to about 450 mmrestricting the free fall of concrete to not more than 2 m. Laitance formed at the top surface of a lift shall be removed to expose coarse aggregates before setting of concrete at the proposed construction joint.As far as possible, construction joints shall not be kept at the location of laps in the vertical steining bars.

The steining of the well shall be built in one straight line from bottom to top such that if the well is tilted, the next lift of steining will be aligned in the direction of the tilt.The work will be checked carefullywiththeaidofstraightedgesoflengthsapprovedbytheEngineer.Plumbbobo rspiritlevel shall not be used for alignment.After sinking of a stage is complete, damaged portions, if any, of steining at top of the previous stage shall be properly repaired before constructing the next stage.

The height of steining shall be calibrated by making at least 4 gauges (preferably in direction along centre line of bridge and in a direction normal to the centre line of bridge) distributed equally on the outerperipheryofthewelleachintheformofa100mmwidestrippainted(preferablyred colour)on the well, with every half a meter mark shown in black paint (mark thickness shall be 5mm).The gauges shall start with zero at the bottom of the cutting edge.Marking of the gauges shall be done carefully with a steel tape.

After reaching the founding level, the well steining shall be inspected to check for any damage or cracks. The Engineer will direct and the Contractor shall execute the remedial measures before acceptanceofthewellsteining.Incasethewellcannotbeacceptedevenwith anyremedialmeasures, then the well shall stand rejected.

Sinking of well should not be started till the steining has cured for atleast 48hrs.The curing of well shall becontinuedupto14daysfromthedayofconcreting.Thecuringcanbebymeansof wateror any approved curing compound.

AnyhoneycombedportionandleakageobservedinthesteiningshallberepairedatCont ractor’sown cost to the satisfaction of Engineer.

BottomPlug

Theconcretemixshallbedesigned(indrycondition)toattaintheconcretestrengthas

mentionedin drawing, andshallcontain10% more cement contentthan thatrequired forthesame mix placeddry, to cater for under water concreting.However, the total cement content shall not be less than 360 kg/cum of concrete with a slump in the range of 150 mm to 200 mm.Admixture may be added to

concretetoimpartherequiredstrength.Thewatercementratioshallnotexceed0.5and theslumpof concrete shall be minimum 150mm.The diameter of tremie pipe shall not be less than 200 mm.

Concrete for the bottomplugshall be laidbyTremie pipe method.Tremie concrete once started shall be continued without interruption for full concreting in the bottom plug.Before commencing plugging,allloosematerialfromthe bottomofthewellshallberemovedandtheinsidefacescleaned thoroughly.

Concreting shall be done in one continuous operation till the dredge hole is filled upto the required heightandthereaftersoundingshallbetakentoensurethattheconcretehasbeenlaidto therequired height.

Leastdisturbanceshallbecausedtothewaterinsidethewellwhilelayingconcreteinthe bottomplug and concrete shall not be disturbed in any way for atleast 14 days.To check any rise in the level of bottom plug, soundings should be taken at the close of concreting and once every day for the subsequent 3 days.

The soundness of bottom plug should be tested by de-watering the well by 5 meters below the surroundingwaterlevelandcheckingtheriseofwater.Therateofriseshall preferablybelessthan10 cm per hour.In case rate is higher, remedial measures as directed by Engineer should be taken by contractor at his own cost.The depth of sump below cutting for bottom plugging shall be $1/6^{th}$ the diameter of well.The contractor shall take permission from Engineer before commencing the bottom plug.All necessary inspections like study of strata at founding level, tilt, shift etc. shall be communicated to Engineer before bottom plugging.If any leakage of water is found, then necessary grouting of the plug and the junction of the well to control the same shall be carried out by contractor at no extra cost.

SandFilling

Sandfillingshouldbecommencedafter 14daysoflayingofbottomplug.Theheight ofbottomplug shall be rectified before starting sand filling.The sand should be clean and free from earth, clay, clods, roots, boulders, shingles etc. and should be backfilled in layers and consolidated by flooding.

WellCap

Theformworkforwellcapshouldbepreparedconformingtotheshapeofwell cap,concretingshould becarriedoutindrycondition.Thebondrodsofsteiningshallbeproperlyanchoredintot hewell cap.

SinkingofWell

Generally, the cutting edge is fabricated and connected to the concrete well curb.On top of the well curb, adequate height of well steining is cast and the process of sinking is carried out.After a portion of the well has been sunk, another height ofwell steiningis cast ontop of previous section andfurther sinkingcarriedout.Theprocessiscontinuedtillthebottomlevel ofcuttingedgereachesthefounding level.

The sinking of the well with use of kentledge shall be commenced only after the steining has been curedforat least 48hrs.Thewell shouldnot beplacedinapre-dredgedhole.Thesinkingofthewell shall befacilitated byexcavating material uniformlyfrominsidethe dredge hole.Use of waterjetting &diversmaybeadoptedforsinkingofwell throughharderstratawithpriorapproval oftheEngineer. The de-watering of well should not be used as a means for sinking of well.Contractor should take necessaryprecautionstoavoidsandblowsandheshouldbepreparedat anypointoftimetotacklethe sand blow problem, in case of any occurrence at no extra cost.

In the process of normal sinking any suitable method other than pneumatic sinking as necessary may be adopted. However, no claim due to any confirmations such as boulders, logs of trees met with during sinking or due to any other difficulty experienced in this process shall be entertained. The methodtobeadoptedforsinkingofwellshall beapprovedbyEngineer.Foranychangeinmethodof sinking the Contractor shall obtain written permission from the Engineer-in-charge. During the operation of sinking of wells, the strata penetrated through and the behaviour of the well shall be reported to the Engineer. The decision of the Engineer on any matter pertaining to sinking shall be final and binding on the Contractor.

As the dredging is in progress, soil samples for the study of soil parameters should be collected for every meter depth and the sample should be preserved as per the standard approved practice by the Contractoratnoextracost.Thedepthofsumpin

wellatanylevelshouldnotbemorethanonemetre. Further the depth of sinking of well for a particular stage shall be restricted to 1 metre to avoid the suddensinkingof welli.e.,jumpingof well.Arecordof depth of dredgingfromthe original bedlevel should be maintained right from the commencement of sinking of well.

If the well is sunk beyond the founding level specified without prior approval of the Engineer due to anyreasons,theContractorwillnotbeentitledforanyextracost.Incase thetopofthewell project’s beyond the required level due to unavoidable circumstance, it shall be responsibilityof the contractor to dismantle such portion of work at his own cost.However the matter should be discussed with Engineer before any work in this regard is carried out.

SinkingHistory

Thesinkinghistoryofwellshouldbemaintainedintheformat giveninAppendix1200/Iof“Ministry of Road Transport & Highways - Roads & Bridges”.

UseofKentledgeasSinkingLoad

Kentledge shall be placed in an orderly and safe manner on the loading platform and in such a way thatitdoesnotinterferewiththeexcavationofthematerialfrominsidethedredgeholea ndalsodoes not in any way damage the steining of the well.When tilts are present or there is a danger of well developing a tilt, the position of the load shall be regulated in such a manner as to provide greater sinking effort on the higher sideof well.

UseofDivers

Useofdiversmaybemadebothforsinkingpurposelikeremovalofobstruction,excavat ionetcand for inspection. All safety precautions shall be taken as per applicable safety code for sinking with divers or any statutory regulations in force.Only persons trained for the diving operation shall be employed and shall be certified to be fit for diving by an approved doctor.

The diving and other equipments shall be of acceptable standard and certified to this effect by an approvedindependentagency.Arrangementsforamplesupplyoflowpressurecleanc oolairshallbe ensured through an armoured flexible hose pipe. Stand by compressor plant shall be provided in case of breakdown.All expenses incurred in use of divers,precautionary measures to be taken, casualties etc., will be at the Contractor’s risk and own cost.

PrecautionsduringSinking

In case wells have to be sunk close to each other and clear distance between them is not greater than thediameterofwell; sinkingshall betakenuponallwellsandtheyshall besunkalternativelysothat sinkingofwellsproceedsuniformly.Simultaneousandevendredgingshallbecarriedout inwellsin such a manner thatthe difference inthelevels ofthesump and cuttingedge n theadjacent wells does not exceed half the clear gap between them.Preferablypluggingof the wells close to eachother can be done together.

Bore chart shall be referred to constantly during sinking for taking adequate care while piercing differenttypesofstrata.Thetypeofsoil asobtainedduringthewell sinkingshouldbecomparedwith bore chart so as to take prompt decisions.

Before seasonal floods all wells sinking of which is in progress shall be sunk to sufficient depths below the designed scour level.Further they shall be temporarily filled and plugged so that they do not suffer any tilt or shift during the floods.The Contractor can ask for any details related to hydraulicslikeHFL,LWL,scourdepthetc.,soastoplanhisworksuitably.Anylossesincurreddue to floods etc., by the Contractor due to improper planning of his work will be under Contractor’s responsibility.No extra payment will be entertained in this regard.

Allnecessaryprecautionsshallbetakenagainstanypossibledamagetotheexistingfoundations,prior to commencement of dredging from inside the well.

The dredged material shall not be allowed to accumulate over the well.It shall be dumped on the downstreamand spread as far away as possible.In case the river streamflows along one edge of the well beingsunk,thedredgedmaterial shall not bedumpedonthedrysideofthebank,but ontheside on which the river current flows.

Verydeepsumpshallnotbemadebelowthewellcurb,asitentailsriskofjumping(suddensinking) of the well.The depth of sump shall be generally limited to $1/6^{th}$ of the outer diameter or 1mwhich ever is less.

Incaseawellsinkssuddenlywithajerk,thesteiningofthewellshallbeexaminedtothesatisfaction of the engineer to see that no damage has occurred to it.

De-wateringshallbeavoidedifsandblowsareexpected.Anyequipmentandmenworkinginsidethe well shall be brought out of the well as soon as there are any indications of a sand blow.

TiltsandShifts

The tilt of any well shall not exceed 1 (horizontal) in 80 (vertical) and the shift at the well base shall not be more than 150mm in any resultant direction.Tilt's and shifts shall be carefully checked and recorded in the format given in appendix 1207. of “Ministry of Road Transport & Highways- Roads & Bridges” regularly during sinking operations.For the purpose of measuring the tilts along the two axesofthebridge,reducedlevelofthemarkspaintedonthesurfaceofthesteiningofthe wellshallbe taken.For determination of shift, locations of the ends of the two diameters shall be precisely measured along the two axes, with reference to fixed reference points.

Thecheckforoccurrenceoftiltshouldbemadeeverydaybeforethecommencementoftheworkand the readings/ findings should be properly recorded and maintained. The check for shift shall be done for every 1.5m of sinking of well. These recordings shall also be properly maintained.

Whenever any tilt is noticed, adequate preventive measures like placing eccentric kentledge, pulling, strutting, anchoring or dredging unevenly and depositing dredge material unequally, putting obstacles below cutting edge, water jetting etc. shall be adopted before any further sinking.After rectification, the dredging shall be uniform and dredged material shall be spread out uniformly.A pair of wells closetoeachotheri.e.,whereclear distancebetweenwellisnotgreaterthanthediameterofwell,they have tendency to come closer while sinking. Timber struts may be introduced in between the steining of these wells to prevent tilting.

In the event of a well developing tilt or shift beyond the specified permissible values, the contractor shallhavetocarryout,athisowncost,suitableremedialmeasurestothesatisfactionoftheEngineer, to bring the tilt and shift within the permissible values, as for as practicable.

If the resultant tilt and /or shift of any well exceed the specified permissible values, the well so sunk shall be regarded as not conforming to specification and a sub standard work. Generally it should not exceed 1 in 50 and 300 mm

respectively. The Engineer in his sole discretion, may consider accepting suchawell,providedthecalculationsforfoundationpressureandsteiningstresses,accountingforthe actualtiltandshiftfurnishedbythecontractorshowthatwellissafe.Anyremedialmeasuresrequired to bring the stresses within permissible values (such as increase in the dimension of the well cap, provision of dummy weights on the well cap) shall be carried out by the contractor without claiming for any extra cost.

In case the Engineer,in hisdiscretionrejectsthewell, the contractor shall dismantle therejected well totheextent directedbyEngineerandremovethedebris.FurthertheContractorshall athisownrisk andexpensecompletethebridgewithmodificationsacceptabletotheEngineer.Thew ellswhichare not conforming to the specified limits of tilts and shifts, if accepted for one or other reasons will be penalisedintheformoflump-sumdeductionspermeterlengthofwellwhichwillbeatthediscretion ofEngineer.

SeatingofWell

The well shall be uniformly seated at the founding strata. After the well has been evenly seated on good hard rock, arrangements shall be made to facilitate proper inspection in dry and visible conditionsbeforethebottomplugislaid.Thefoundinglevelsshowninthedrawingsare purelybased on thedata availablefromgeo-technicalinvestigations.The Engineer on inspection will decide upon any modifications that may be required to meet the structural aspects.The bottom plugging shall be commenced only after this inspection and concurrence from Engineer.

TolerancesforWellSteiningandWellCap

Thepermissibletolerancesareas follow:

(a)	Variationin dimension	:	+50mm-10mm
(b)	Misplacementfromspecifiedposition	:	15mm
(c)	SurfaceIrregularitiesmeasuredwith3mstraightedge:		5mm
(d)	Variationoflevelsatthetop	:	±25mm

MeasurementforPaymentofSinkingofWell

Thedepthofsinkingshallbemeasuredfromthenaturalbedleveltothebottomofthewell curb.

PART10B

PARTICULARTECHNICALSPECIFICATIONSFORCIVIL,STRUCTURAL AND PUMPING MAIN/SEWER NETWORK

CONTENTS

PART-10B

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PART-10B

PARTICULARTECHNICALSPECIFICATIONSFORCIVIL,STRUCTURALAND SEWER NETWORK

A. StandardBasic Specifications

The "Standard Basic Specifications" Part-10A shall be followed for construction of General Works underthis contract of BWSSB. Specificationsforadditional specialized items of civil works are as set out in Part 10B, Particular Technical Specifications, of this Section.

In the event of any discrepancy between the provisions of the Standard Basic Specifications and the Particular Technical Specifications, the provisions of the Particular Technical Specifications shall prevail.

B. ParticularTechnicalSpecificationsforSTP,TSPS,ISPS&Connected Works

2 DesignSubmissions

Beforeproceedingwithdesignanddrawingpreparation,theContractorshallsubmitd etailedgeneral philosophy of design (Design Basis Report) of various parts of (all) the structures and equipment foundations along with explanatory sketches for review. Only after the review and incorporation of comments on the general philosophy, as offered during the review, the Contractor shall submit any design document and/or drawing for review and approval for construction.

DesignPhilosophy

Followingarethedetailswhicharetobeincludedinthegeneraldesignphilosophydocu ment submission:

1. Designassumptions/ philosophyforLiquidRetainingStructureswithvariousboundary conditions as applicable
2. Designassumptions/philosophyforbuildings
3. Designassumptions/philosophyforallotherstructures
4. Standard General Notesshallinclude material properties (grade,strength, unit weight etc.), developmentlengths,lap/splicelengths,Anchoragelengthsundertensionan dcompression, clear cover, water proofing specifications, legend used etc.

StandardDetails

Followingtypicaldetailsshallalsobesubmittedforapprovalpriortoproceedingwithdetailed design :

1. Reinforcement detail showing the development length at Column/Footing intersection, Column and Roofbeamintersections, Walls and Baseslabintersections,Walls and cover slab intersections.
2. Detailing of the reinforcement for columns, beams, beam/column intersection,footing/column intersection, and Slabs as per relevant code provisions/requirements depending upon the assumptions made in the

design as applicable.

3. Reinforcementdetailforcut-outsinslabsandwallswithmaximumsizeofcut-outs

4. ReinforcementdetailattopofRCCtrenchwallsshowingedge/seatingangles

5. Pouring sequence of concrete and standard details for construction joints, expansion joints,contraction joints, etc.

6. DetailsofOpening/ManholesandRungsto beplacedinthetanks

7. Detail for rain water drainage downtakes at terrace slab and water proofing at roof/sunkenslabs

8. Detailforstormwaterdrain,Roads,plinthprotectionandentrancerampstobuildings

9. Detail for Handrails and fixing detail of handrail to concrete, Steel Ladders and fixing detailof ladders to Walls/Concrete, Cage ladders, Boundary walls, Fencing and Gates, etc.,

Submission

Contractorshallsubmitthedetaileddesignanddrawingsonlyafteritemsmentionedunder clause 1.1and1.2areapprovedoras directedbytheEngineer

Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to the Engineer. Separate design calculations for foundations or superstructures submitted independent of each other shall be deemedto be incomplete and shall not be accepted by the Engineer.

Submissions of detailed design calculations and Good for Construction drawings shall include the following as a minimum:

A. DetailedDesignCalculations
    1. One (1) Copy of a Compact Disc (CD) containing electronic files relevant to the structure’smodelling,analysisanddesigncalculations(MicrosoftExcel ,STAADPro, etc.). Files submitted shall be in editable format.

    2. Printcopy(7Copies)ofthecontentsassubmittedintheCompactDisc.

B. GoodforConstructionDrawings
    1. One (1) Copy of a Compact Disc (CD) containing AutoCAD files (Civil General Arrangement, Structural Dimensions and Reinforcement Details) pertaining to the structure. Files submitted shall be in editable format.

    2. Print copy (7Copies) of the contents as submitted in the Compact

Disc. Prints to be submitted on A1 Size Sheet as a minimum or A0 Size Sheet when required by the employer.

3. Bar-bending schedule indicating the number, shape and size of the rebars shall be submitted as part of the Reinforcement Details.

4. Detailed drawing showing the location, number and depth of inserts shall be included for any structural steel inserts/Metal inserts in the structure such as rungs, bolted connections for ladders/railings, etc.

5. Location of Construction Joints and pour sequence shall be included on the drawing for base slabs, walls and top slabs.

6. Revised drawings shall be submitted by clouding at the location with the latest revision number and also show the history of revisions in a table format just abovethe title block.

The design considerations described here under establish the minimum basic requirements of plainand reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of partly completed structures.

DesignStandards

All the designs shall be based on the latest Bureau of Indian Standard (BIS) Specifications or Codesof Practice. The design standards adopted shall follow the best modern engineering practice in the field based on any other International Standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by the Engineer. In case of any variation or contradiction between the provisions of the BIS Standards or Codes and the specifications given along with the tender document, the provision given in this Specification shall be followed.

All reinforced concrete structural design shall generally conform to the following publications of the Indian Standards Institution:

IS:456 :CodeofPracticeforplainandreinforced concrete
IS:875 :CodeofPracticefordesignloadsforbuildingsandstructures(PartItoV)
IS:3370 :CodeofPracticeforconcretestructuresforthestorageofliquids(PartItoIV)
IS:1893 :Criteriaforearthquakeresistantdesignofstructures(Part1to4)
IS:2974 :CodeofPracticefordesignandconstructionofmachinefoundations(Part1to4)
IS:2911 :CodeofpracticeforDesignandconstructionofPilefoundations. (Parts1to4)

IS:13920 :DuctileDetailingofReinforcedConcreteStructuressubjectedtoSeismic forces-
CodeofPractice.

IS:4326 :CodeofPracticeforEarthquakeResistantDesignandConstructionof Buildings

IRC:6 :StandardspecificationandCodeofPracticeforroadbridgesLoadsa nd Stresses
SP: 16 :DesignAidsforReinforcedConcretetoIS456

SP: 34 :HandbookonConcreteReinforcementandDetailing.
SP: 23 :HandbookonConcreteMixes.

AllstructuralsteeldesignshallgenerallyconformtothefollowingpublicationsoftheIn dianStandards Institution:

I.S:800 : CodeofPracticeforgeneralconstructioninsteel
I.S: 806 :

CodeofPracticeforuseofsteeltubesingeneralbuildingconstruction SP:
38 : Handbook of Typified Design of Structures with Steel
Roof Trusses

DesignLife

Thedesignlifeofallstructuresandbuildingsshallbe60 years.

DesignLoadings

All buildings and structures shall be designed to resist the worst combination of the following loads/stresses under test and working conditions; these include dead load, live load, wind load,seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads.

DeadLoad

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment's and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included, but excluding contents, shall be considered.
Dead loads shall be in general as per I.S. 875 Part (I). However, the following **minimum loads** shall be considered in design of structures:

(i)	Weightof water	9.81 kN/m^3
(ii)	Weight of soil (irrespective of strata available at site and type of soil used for filling etc). However,for checkingstabilityagainst uplift, actualweightofsoilasdeterminedbyfie ldtest shallbe considered	20.00 kN/m^3
(iii)	Weightof concrete	24.00 kN/m^3

(iv)	Weightofreinforcedconcrete	25.00 kN/m^3
(v)	Weightofbrickwork(exclusiveof plaster)	22.00N/m^2permmthicknessof brickwork
(vi)	Weight of Solid ConcreteBlock work	24.00N/ m^2permmthicknessofblock

	(exclusiveof plaster)	work
(vii)	Weightofplastertomasonrysurface	18.00N/m^2permmthickness
(viii)	Weightofgranolithicterrazzo finishor renderingscreed,etc.	24.00N/m^2permmthickness
(ix)	Weightofsand(filter media)	26.0 kN/m^3
(x)	Weightofalumblocks	24.20 kN/m^3

Live Load

Live Load (LL) shall include the superimposed loads due to the use/occupancy of the structure/buildingnotincludingdead,windorearthquakeload.Liveloadsshallbeingeneralasper
I.S. 875 Part (II). However, the following **minimum live loads** shall be considered in the design ofstructures:

(i) Liveloadonroofs(accessiblebystaircase) : 1.50 kN/m^2

(ii) Live load on floors supporting equipmentsuchaspumps,blowers, compressors,valvesetc. : 10.00 kN/m^2

(iii) Liveloadonallother floors walkways, stairways and : 5.00kN/m^2platforms

(iv) LiveloadonToilet areas : 2.00 kN/m^2

(v) Surchargeforundergroundstructures Includingchannels,sumps,cable&pipetrenchesetc. : 20.00kN/m^2

In the absence of any suitable provisions for live loads in BIS Codes or as given above for any particulartype offloororstructure, assumptions mademust receivetheapprovalof the Engineer prior to starting the design work. Apart from the specified live loads or any other load due to material

stored, any other equipment load or possible overloading during maintenance or erection/construction shall be considered and shall be partial or full whichever causes the most critical condition.

WindLoad

WindloadsshallbeasperI.S.875Part(III).

EarthquakeLoad

This shall be computed as per I.S. 1893.An importance factor appropriate to the type of structure shall be considered for design of all the structures. For design of all Process buildings and structures an importance factor of 1.75 shall be adopted.

DynamicLoad

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, travelling cranes, etc. shall be considered in the design of foundation of such structures. As a guide, themassofthefoundationshouldbeatleast2.5timesthemassofthewholemachineora sprovided by the manufacturer/Vendor for dynamic analysis.

VehicularWheelLoad

ForanystructureorpipelinebelowtheroadsClassAloadingofIRC6shallbeconsidered.

Joints

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However, contraction joints shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for walls and rafts.

Expansion joints of suitable gap at suitable intervals not more than 30 m shall be provided in walls,floors and roof slabs of liquid retaining structures.

Constructionjointsshallbeprovidedatrightanglestothegeneraldirectionofthemem ber.The locations of construction joints shall be decided on convenience of construction.

To avoid segregation of concrete in walls, vertical construction joints are normally to be provided at corners and junction of walls and in Base slab. PVC water stops of 150mm width shall be used for walls and 230mm width for base slabs.

DesignCriteriaforUndergroundorPartlyUndergroundLi quidRetaining Structures

Water level is assumed at the ground level for design of all the structures. All underground or partly underground liquid containing structures shall be designed for the following conditions:

(i) Any structure in contact with water, submerged water or flowing water shall be designed inaccordance with provisions made in IS3370.

(ii) Liquid depth up to full height of wall: no relief due to soil pressure from outside to be considered. Structure empty (i.e., empty of liquid, any material, etc.): full earth pressure and surcharge pressure wherever applicable, to be considered.

(iii) If water table exists, earth pressure to be considered for submerged soil conditions with reference to geotechnical recommendations, approved by the Engineer.

(iv) Partition wall between dry sump and wet sump: to be designed for full liquid depth up to full height of wall.

(v) Partition wall between two compartments: to be designed as one compartment empty and other full.

(vi) Structures shall be designed for uplift in empty conditions with the water table considered at FGL.

(vii) Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads (Hydrodynamic Impulsive Pressure).

(viii) For general retaining walls and large sized tanks where the walls are designed as retaining walls, sliding check shall also be performed along with over turning checks.

Overturning: The stability of a structure as a whole against overturning shall be ensured so that the restoring moment shall be not less than the sum of 1.2 times the maximumoverturning moment due to the characteristic dead load and 1.4 times the maximum overturning moment due to the characteristic imposed loads. In cases where dead loadprovidestherestoringmoment, only0.9 times thecharacteristic dead load shall beconsidered. Restoring moment due to imposed loads shall be ignored.

(ix) **Sliding:** The structure shall have a factor against sliding of not less than 1.4 under the most adverse combination of the applied characteristic forces. In this case only 0.9 times the characteristic dead load shall be taken into account as per IS codes.

(x) Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. The stability of the structure should be checkedagainstupliftusingFactorofsafetyof1.2.Theindividualmembersshall bedesigned for stresses due to uplift forces.

(xi) All theliquidretainingstructures shall be designfor maximumdesign

crackwidths of 0.1mm for direct tension and flexure.

(xii) In case of Large and Deep Underground Tanks, the analysis can be carried by Finite Element Method usingSTAAD.Proor anyother equivalent software predominantlyusedand accepted in the industry.

Foundations

(i) The minimum depth of foundations for all structures, equipments, buildings and frame foundations and load bearing walls shall be as per IS 1904 but in any case this shall not beless than 1.0 meter in the original soil.

(ii) Maximum safe bearing capacity of soil strata shall be taken as determined by the Bidder through his own independent investigations. Geotechnical reports of proposed sites covered under thecontract areavailable withthe employer forreference. It maybe used byContractor as part of, in addition to, or in lieu of such investigations at his own risk.

(iii) The Bidder shall ensure the technical feasibility of the offer submitted after visiting the sites and conductingindependent investigations. It must beclearlyunderstood bythe bidder that as the contract is Design , Build and Operate, the contractor shall be required to design and execute every such item(s) of work(s) which are considered required or necessary for the satisfactory completion and functioning of the entire work, commissioning of electro- mechanical equipment , Instrumentation, SCADA systems, trial run and operation and maintenance , and any other items required but not specified in the bid document, but are essential to complete the scheme. Nothing extra or additional shall be paid to the contactor on account of his failure of understanding.

(iv) Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, eitherexistingor not withinthescopeofthis Contract.Suitable adjustments indepth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.

(v) Special attention is drawn to danger of uplift being caused by the ground water table. All underground structural slabs shall be designed for uplift forces due to ground water pressure.

(vi) EGL (Existing ground level) and FGL (Finished ground level) shall be marked on alldrawings showing foundation/sub-structure details and related design documents.

(vii) Machine/static equipment foundations shall be separated from adjoining parts of buildings, other foundations and floor/pavement slabs. Joints at floor/pavement slabs shall be suitably sealed.

(viii) Foundationsandstructuresformachinessubjecttovibrationsshallbesoproportionedthatthe amplitude and frequency of the foundation/structure are within the permissible limits as per relevant BIS codes (or as required by the machine vendor).

(ix) Machine foundations shall be designed and detailed as per IS: 2974. All appendages to such foundations shall be reinforced suitably to ensure integral action.

(x) PileFoundations-Design, TestingandExecutionofpilesshallbeconsideredasperprovision of relevant codes (conforming to latest version of IS: 2911), and in compliance with the Geotechnical report recommendations as applicable.

DesignRequirements

Thefollowingarethedesignrequirementsforallreinforcedorplainconcretestructures:

a) AllblindingandlevelingconcreteshallbeaminimumM10.

b) All liquid retaining reinforced concrete structures, concrete shall be of a minimumM30 grade and Buildings,shallbeofaminimumM25 grade(Footings, PlinthBeams, Columns, Slaband beams, etc., i.e. which are other than liquid retaining structures). Further, if there are any liquid retaining RCC tanks coming up with in the buildings, concrete shall be of minimum M30 grade for such RCC tanks also.

c) The reinforced concrete for liquid retainingstructures shall have a minimum cement content of 400 kg/m^3 for M30 grade concrete and building structures shall have minimum cement content of360 kg/m^3 with M25 grade concrete. Reinforced concrete shall have maximum slump of 100 mm and maximum water cement ratio of 0.48.

d) The minimum clear cover to all reinforcement including stirrups and links shall be 60 mm for all liquid retaining structures except for Launders/Gutter Slabs cover shall be 45mm.As design consideration to control crack, though general requirements of IS 3370 shall be followed, permissible crack width shall be limited to 0.1 mm for liquid retaining structures.

e) The minimum amount of reinforcement in each of the two directions at right angles within each surface zone should be provided as per clause 8.1 of IS 3370 (Part 2):2009.Definitionof surface zones is clearly shown in Figure 1 and Figure 2 of IS 3370 (Part 2): 2009. Forslabs, minimum of 10 mm dia bars shall be used to avoid any deformation of lesser diameter bars under loads prior to construction. Any liquid retaining structures which are more than 165mm thickness shall have reinforcement on both the faces..

f) Theminimumcovertothemainreinforcingbarsfordifferentmembers

1. Non–liquidretainingstructuresshallbeasfollowsunlessstatedotherwise:

Slab(Floor,Roof,Canopy, andStaircase)	30 mm
Shell roof for Filter house/Clarifiers	
25mm Beams(Sides,Bottom&Top)	40

mm

Lintels(all around)	30 mm
Columns	50 mm
Pedestals (in contact with earth)	

50mm Basement wall, Retaining walls

i) Facein contactwith earth	50 mm
ii) Interiorface	40 mm
Foundations	50 mm

2. Liquidretainingstructuresshallbeasfollowsunlessstatedotherwise:

Walls–Faceincontactwith earth	60 mm
Walls–Faceincontactwith water	60 mm
Baseslab incontactwithwater	60 mm
Baseslab incontactwithsoil	60 mm
Launders/Gutterslabs	45 mm
Roofslab	45 mm
Manhole	50 mm

g) For reinforced concrete structures, reinforcement shall be HYSD-CRS (Corrosion Resistant Steel) of Grade Fe 500. All physical and chemical properties of this Fe 500 grade steel shall confirmtoIS:1786-2008.Weldedwirefabricshall conformtoIS:1566asshownorspecified on the drawing. The CRS (corrosion resistant steel) index shall be at least 1.35 when testedfor Salt Spray test as per "ASTM B 117 – 2009 test procedure for 120 hours when compared with the Fe 500 normal reinforcement bars and with same bar diameter. All test results (including physical and chemical properties and salt spray tests) have to be produced for the respective bar diameter for each consignment of steel delivered at site and at a frequency of every 20 Metric Tons.

h) Reinforcement bars and structural steel to be procured only from Primary steel producers/Integrated Steel Plants such as SAIL/RINL/JSW/SHYAM STEEL/TATA STEEL using iron ore as the basic raw material and having in-house iron making facilities followedby production of liquid steel and crude steel with in-house rolling, adopting BF-BOF route or DRI-EAF technology as per Ministry of Steel guidelines. No Re-rolled material/secondary steel shall be accepted or allowed for any structural works. 7The steel manufacturingcompany should have latest ISO accreditation for Quality Management System.

i) All buildings shall have a minimum 1 meter wide, minimum 100 mm thick plinth protection paving in M15 grade concrete. Plinth protection shall be supported on well compacted strata of soling about 150mm/ plain cement concrete as required.

j) All pipes and ducts laid below the structural plinth and road works shall be surrounded with concrete of grade M15 having minimum 150 mm thick concrete or D/4 (D = outer dia. of pipe) thickness whichever is more.

k) Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.

l) Detailing of the reinforcement shall be considered as per latest Indian code of practices and special publications as applicable.

m) Anystructureorpipelinecrossingbelowroadsshallbedesignedfor ClassAofIRCloading.

n) Sliding layer or slip layer shall be provided between sub base and structural slab (Raft). Polythene sheets of 500 microns shall be provided as sliding layer as per IS specification.

o) Water tightness testing of liquid retaining structures shall be done in accordance with IS: 3370, (Part I) - 2009. It is described in Clause 1.31 of this document. The depth of water for testing shall be as per design depth.

p) A layer of 450mm thick rubble packing with approved stone, set in regular lines, hand- packed, filling the interstices with approved small stone chips and sand, consolidating by ramming or compacting with heavy roller after watering including spreading of 12mm layerof stone grit on top shall be carried out for all building works below grade slabs/rafts/footings under water logged conditions/high water table conditions.

The following minimum thicknesses shall be used for different reinforced concrete members, irrespective of design thicknesses:

(i)	Wallsforliquidretainingstructures	:	250 mm
(ii)	Roofslabsforliquidretainingstructures (Otherthanflatslabs)	:	200 mm
(iii)	Bottomslabs/Raftforliquidretainingstructures	:	300 mm
(iv)	Floorslabsincludingroofslabs,walkways, canopyslabs	:	125 mm
(v)	Wallsofcables/pipe trenches, undergroundpitsetc.	:	200 mm
(vi)	Columnfootings	:	300 mm
(vii)	Parapets	:	100 mm
(viii)	Precasttrenchcover,Chajjaandallfascias	:	100 mm
(ix)	ColumnDimension		
	a)Exceptionalcase(Basedonanyspecificrequirement)		
	i)Tomatchwithwidthofblockmasonrywall	:	200mm
	ii)Tomatchwithwidthofbrickmasonrywall	:	230mm
	b)Ingeneralcase	:	300mm
(x)	Beam(Tomatchwithwidthofblockmasonrywall)	:	200mm
(xi)	LaunderBaseSlab/Bafflewalls	:	200 mm
(xii)	LaunderVerticalWall,BaffleWall,GutterSlab	:	175 mm
(xiii)	Grade Slabs	:	200 mm

MaterialsinGeneral

The term "materials" shall mean all materials, goods and articles of every kind

whether
raw,processedormanufacturedandequipmentandplantofeverykindtobesuppliedb
ytheContractorfor incorporation in the Works.

Except as may be otherwise specified for particular parts of the works the provision of clauses in "Materials and Workmanship" shall apply to materials and workmanship for any part of the works.

All materials shall be newand ofthe kindsand qualities describedin the Contractand shallbe at least equal to approved samples.

As soon as practicable after receiving the order to commence the Works, the Contractor shall inform to the Engineer of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of the Engineer which may be withheld until samples have been submitted and satisfactorily tested.The Contractor shall thereafter keep the Engineer informed of orders for and delivery dates of all materials.

Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damageorcontaminationfailingwhichsuchdamaged materials shallberejectedandshallnotbeused on any part of the Works under this contract.

Samplesand Testsof Materials

The Contractor shall submit samples of such materials as may be required by the Engineer and shall carry out the specified tests directed by the Engineer at the Site, at the supplier's premises or at a laboratory approved by the Engineer.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer.

The Contractor shall give the Engineer seven days' notice in writing of the date on which any of the materials shall be ready for testing or inspection at the supplier's premises or at a laboratory approved by the Engineer.The Engineer shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by the Engineer to carry out such a test on a mutually agreed date in his presence.The Contractor shall in any case submittoEngineerwithinsevendays ofeverytestsuchnumberofcertifiedcopies(notexceedingsix) of the test results as the Engineer may require.

Approval by the Engineer as to the placing of orders for materials or as to samples or tests shall not prejudice any of the Engineer's powers under the Contract.

Theprovisionsofthisclauseshallalsoapplytomaterialssuppliedunderanynominatedsub-contract.

Standards

Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current on the date of submission of the tender.

Where the relevant standard provides for the furnishing of a certificate to the Engineer, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to the Engineer.

The specifications, standards and codes listed below are considered to be part of this specification.All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between the Specification and the Standards referred to herein, the Specification shall govern.

a) Materials

IS:269 - SpecificationfororordinaryPortlandcement.
IS: 383 -

Specificationforcoarseandfineaggregatesfromnaturalsourcesforconcrete
IS: 428 - Specification for distemper, oil emulsion, colour as required
IS: 432 -

Specificationformildsteelandmediumtensilesteelbarsandharddrawnsteel wire for concrete reinforcement (Parts 1 & 2)
IS:455 - SpecificationforPortlandslagcement
IS: 458 -

Specificationforprecastconcretepipes(withandwithoutreinforcement)
IS: 650 - Specification for standard sand for testing of cement
IS: 651 -

Specificationforsaltglazedstonewarepipesandfittings IS:
777 - Specification for glazed earthenware tiles
IS: 808 -

Specificationfordimensionsforhotrolledsteelbeam,columnchanneland angle sections
IS: 814 - Specification for covered electrodes for manual metal arc welding of

Carbon and Carbon Manganese steel
IS: 1003-

Specificationfortimberpaneledandglazedshutters(Parts1&2)
IS: 1038- Specification for steel doors, windows and ventilators
IS:1077- Specificationforcommonburntclaybuildingbricks
IS: 1398-

Specificationforpackingpaper,waterproof,bitumenlaminated

IS: 1489- Specification for Portland pozzolana cement (Parts 1 & 2)
IS: 1566-

Specificationforharddrawnsteelwirefabricforconcretereinforcement IS: 1580- Specification for bituminous compounds for water proofing and caulking purposes
IS: 1786-

Specificationforhighstrengthdeformedsteelbarsandwiresforconcrete reinforcement
IS: 1852-

Specificationforrollingandcuttingtolerancesforhotrolledsteelproducts
IS: 1948- Specification for aluminium doors, windows and ventilators

IS: 1977- Specification for structural steel (ordinary quality) IS: 2062-

Specificationforsteelforgeneralstructuralpurposes
IS: 2140-

SpecificationforStrandedGalvanizedSteelWireforFencing
IS: 2185- Specification for concrete masonry units (Parts 1 & 2)
IS: 2202- Specification for wooden flush door shutters (Parts 1 & 2) IS: 2645-

Specificationforintegralcementwaterproofingcompounds

IS:2750- Specificationforsteelscaffoldings
IS:2835- Specificationforflattransparentsheet glass
IS: 3384-

Specificationforbitumenprimerforuseinwaterproofinganddampproofing
IS: 4021- Specification for timber door, window and ventilator frames
IS: 4350-

Specificationforconcreteporouspipesforunderdrainage
IS: 4351- Specification for steel door frames
IS:4990- Specificationforplywoodforconcreteshutteringwork
IS: 9862-

Readymixedpaint,brushing,bituminous,black,leadfree,acid,a lkali,water and chlorine resisting
IS: 10262- Recommended guidelines for concrete
mix design IS: 12330-

SpecificationforsulphateresistingPortlandcement
IS: 12709-

Glassfiberreinforcedplastics(GRP)pipes,jointsandfittingsforuse for potable water supply

b) Tests

IS:516 - Methodoftestforstrengthofconcrete
IS: 1182 - Recommended practice for radiographic examination of fusion - welded butt joints in steel plates
IS:1199 - Methodsofsamplingandanalysisof concrete
IS: 2386 -

Methodsoftestforaggregatesforconcrete(Parts1to8) IS:
2720 - Methods of test for soils (Parts 1 to 39)
IS:2911 - CodeofPracticefordesignandconstructionofPilefoundations(Part 4)
IS: 3025 -

Methodsforsamplingandtest(physicalandchemical)forwateran d wastewater (Parts 1 to 59)
IS:3495 - Methodoftestforburntclaybuildingbricks(Parts1to4)
IS: 3613 -

Acceptancetestsforwirefluxcombinationforsubmergedarcwelding IS:
4020 - Methods of tests for wooden flush doors shutters: Type tests
IS:4031 - Methodsofphysicaltestsforhydraulicccement(Parts1to15)
IS:5807 - Methodoftestforclearfinishesforwoodenfurniture(Parts1to6)
IS: 7318 - Approval tests for welders when welding procedure approval is not required (Parts 1 and 2)
IS: 13311 - MethodsofNon-destructivetestingofConcrete:Part1&Part2

c) Codesof Practice

Codeofpracticeforplainandreinforcedconcrete Code of
practice for laying of concrete pipes Code of practice for
general construction in steel
Codeofpracticeforuseofsteeltubesingeneralbuildingconstruction

IS:456 -
IS:783 -
IS:800 -
IS:806 -
IS:816 - Code of practice for use of metal arc welding for general construction in mild steel
IS:817 - Codeofpracticefortrainingandtestingofmetalarc welders
IS:875 - Code of practice for design loads (other than earthquake) for building structures (Parts 1 to 5)

IS: 1081 - Code of practice for fixing and glazing ofmetal (steel andaluminium)doors,windows and ventilators
IS: 1172- Codeofpracticeforbasicrequirementsforwatersupply,drainagea nd sanitation
IS: 1477- Codeofpracticeforpaintingofferrousmetalsinbuildings(Parts1&2) IS: 1597- Code of practice for construction of stone masonry (Parts 1 & 2)
IS:1742- Codeofpracticeforbuildingdrainage
IS:1893- Criteriaforearthquakeresistantdesignofstructures(Part1)
IS:1904- CodeofPracticeforDesignandConstructionofFoundationinSoils: General Requirements.
IS: 1948- Specificationofaluminiumdoors,windowsandventilators
IS: 2065- Code of practice for water supply in buildings
IS:2204- Codeofpracticeforconstructionofreinforcedconcreteshellroof
IS: 2210- Codefordesignofreinforcedconcreteshellstructuresandfoldedplates
IS: 2212- Code of practice for brickwork
IS: 2338- Codeofpracticeforfinishingofwoodandwoodbasedmaterials(Parts1&2) IS: 2394- Code of practice for application of lime plaster finish
IS: 2395- Codeofpracticeforpainting,concrete,masonryandplast ersurfaces (Parts 1 & 2)
IS:2470- Codeofpracticeforinstallationofseptictanks(Parts1&2)
IS: 2502- Codeofpracticeforbendingandfixingofbarsforconcretereinforcement
IS: 2571- Code of practice for laying in-situ cement concrete flooring
IS:2595- Codeofpracticeforradiographictesting
IS: 2751- Recommended practice for welding of mild steel plain and deformed bars forreinforced construction
IS:2911- CodeofPracticefordesignandconstructionofPilefoundations
IS: 2974- Codeofpracticefordesignandconstructionofmachinefo undations (Parts 1 to 4)
IS:3114- CodeofpracticeforlayingofCastIron pipes
IS: 3370 - Codeofpracticeforconcretestructuresforthestorage

ofliquids (Parts 1 to 4)
IS:3414 -Codeofpracticefordesignandinstallationofjointsin buildings
IS: 3558 -Codeofpracticeforuseofimmersionvibrators forconsolidatingconcrete IS: 3658 -Code of practice for liquid penetrate flaw detection
IS:3935 -Codeof practiceforcompositeconstruction
IS: 4000 -Code of practice for High strength bolts insteel structures IS:4014 -Codeofpracticeforsteeltubularscaffolding(Parts1&2)
IS: 4111 -Codeofpracticeforancillarystructuresinseweragesystem(Parts1to4)
IS: 4127 -Code of practice for laying of glazed stoneware pipes
IS: 4326 -CodeofpracticeforEarthquakeResistantDesignandConstructionofBuildings
IS: 4353 -Recommendations for submerged arc welding of mild steel and low alloy steels IS: 5329 -Code of practice for sanitary pipe work above ground for buildings
IS:5334 -Codeofpracticeformagneticparticleflawdetectionof welds
IS: 5822 -Codeofpracticeforlayingofweldedsteelpipesforwatersupply IS: 7215 -Tolerances for fabrication of steel structures
IS:9595 -Recommendationsformetalarcweldingofcarbonandcarbonmanganese steels

IS:10005-

SIunitsandrecommendationsfortheuseoftheirmultiplesandofcertain otherunits

SP: 16 -DesignAidsforReinforcedConcretetoIS456

SP: 34 -HandbookonConcreteReinforcement andDetailing

SP: 38 -HandbookofTypifiedDesignofStructureswithSteelRoofTrusses

d) ConstructionSafety

IS: 3696 -

Safetycodeforscaffoldsandladder(Parts1&2) IS:
3764 - Safety code for Excavation work
IS:7205 -Safetycodeforerectionofstructuralsteelwork

GeneralArrangementof Plant

ThefollowinggeneralguidelinesshallbefollowedinthepreparationofgeneralarrangementofPlant:

- Sufficient room shall be allowed between components of plant and adjacent Plant or fixed structures to permit safe and convenient access for operation and maintenance.

- AnareaadjacenttoallmechanicalPlantshallbeprovidedasmaintenancelaydown area.

- fixed runways , lifting eyes or other means shall be provided to permit the removal of Plant that may be required to be removed duringthe course of its normal operational life for maintenance or any other purpose.

- areas where leakage is likely to occur whether in normal use or duringmaintenanceshall be provided with covered drainage channels which shall direct spillage either to a suitable plant drain or to a sump from where it can be pumped to plant drain.

Orientation

The works shall be laid out within the confines of the Site in order to interface to the existing infrastructure of roadways and inlet and outlet pipe work. Underground services requiring to be relocated in order to accommodate the proposed site layout shall, with the approval of the Engineer,be relocated by the Contractor.

Buildingsand Structures

All the building and structure works shall generally comply with the following Employer’s Requirements unless otherwise specified elsewhere.

7. All building works shall be of reinforced concrete framework (Concrete Grade of M25 as a minimum).

8. All external walls shall be in solid cement concrete blocks of concrete grade M15 and shall be provided as per IS: 2185 (Latest Revision) and shall be 200 mm thick.

9. All internal partition walls shall be in solid concrete blocks of concrete grade M15 and shall be provided as per IS: 2185 (Latest Revision). All internal walls shall be 200mm thick except for toilets. Toilet partition walls shall be in 100 mm thick solid concrete block.

4. (a) Finishestoconcreteliquidretainingstructuresshallbe:
F1 - Externalsurfaces,buried
F2 -
Externalsurfacesexposedandupto300mmbelowgroundlevel
F2 - Internal surfaces
(b) Finishestootherconcretestructuresshallbe:
F1 - Buried
F1 - Exposed,whereplasteringisspecified
F2 - Exposed

The type of finishes is explained in “Standard Basic Specifications for Civil and Structural Works” in Chapter 4.

5. All internal masonry surfaces finish shall have 12 mmthickplain faced cement plaster in cement mortar(1:4)withneatcementfinishontop.Overthis,onecoatofprimerandtwo coatsofplastic emulsion paint of approved quality and shade shall be provided.

6. All external masonry surfaces and concrete surfaces with rough board finish shall have 20 mm thick sand faced cement plaster in two coats, base coat 12 mm thick in cement mortar 1:4 and finishing coat 8 mm thick in cement mortar 1:4. Waterproofing compound of approved makeandquality shallbe addedto the cement mortar inproportionsasspecifiedby the manufacturer.

7. All external surfaces above ground level shall have one coat of primer and two coats of waterproof cement-based paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon.

8. Toilet areas, walls and ceilings, shall have one coat of primer and two coats of plastic emulsion paint.

9. Toilet floor slab shall be filled with brick bat coba (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company.

10. The finished floor level intoilet areas shall be25 mmbelow generalfinished

floor level elsewhere in the building.

11. The flooring in operator’s room, loading/unloading bay, MCC cum Panel room shall be in 25mmthick Kota stone slab of approved shade and pattern and placed over 20 mmthick base of cement mortar 1:4 to give overall thickness of 45 mm. Half tile skirting shall also be provided in these areas.

12. The flooring in the pumping stations, chlorination building, centrifuge building, workshop, blower room, chemical building, security room, D.G.Room, any other equipment room,etc.., shall be 60mm thick cement flooring with Metallic concrete hardener topping, under layer of 42mm thick cement concrete 1:2:4 (1 cement : 2 coarse : 4 graded stone aggregate 16mm thick nominal size) and top layer of 18mm thick metallic concrete hardener consisting of mix 1:2 (1 cement : 2 stone aggregate 6mm nominal size) by volume & mixed with metallic hardening compound of approved quality @ 3 kg/m^2. Including cement slurry and rounding off edges.

13. Toilet areas shall have 300 mm x 600 mm x 6 mm thick ceramic non slippery tiles placed in cement mortar 1:4 to give an overall thickness of 50 mm. 2100 mm high dado, in 150 mm x 150 mm x 6 mm thick glazed tiles (approved make, shade and pattern) placed in cement mortar 1:3 shall also be provided in these areas.

14. The flooring along with skirting in administration building including PLC and SCADA Room shall be 20 mm thick mirror polished, machine cut granite slab of approved shade and pattern placed in cement mortar (1:4). 150mm high skirting shall be provided in these areas. 750mmwide Granite stone shall be provided for laboratory platforms fixed over double sandwiched support as directed and the edges of granite is to be embedded into the wall.

15. The laboratory shall consist of cupboards/ almirahs/ cabinets made from suitable marine grade waterproof plywood. The floor tiles and dado shall be done with ceramic unglazed vitreous Acid resistant tiles 300mm x 300mm size of approved quality.

16. Thetoiletfacilitiesshallincludeatleast:

(i) 2Nos.Waterclosetswith white porcelainOrissapan minimum 580mm long with flushing cistern of 10 liters capacity.

(ii) 2 Nos. Urinals of sizes 600mmx 400 mmx 300 mmflat backtype in white porcelain separated by a marble partition of size 680 mm x 300 mm.

(iii) 2 Nos. washbasinsofsize510 mmx 400 mmin white porcelainwith inlet, outlet and overflow arrangements.

(iv) 2Nos.mirrorofsize400mmx600 mmwallmountedtypefittedoverwashbasins.

(v) 2Nos.plasticliquidsoap bottles.

(vi) 2Nos.Stainlesssteeltowelrailsminimum750mmlong.

(vii) Allstopcocks,valvesandpilarcocksshallbeheavydutychromiumplated brass.

(viii) Allfittingssuchas`P’or`S’traps,floortraps,pipes,downtakepipes etc.

(ix) The sewage from toilet blocks shall be led to the wet well of terminal sewagepumping station if present under this contract or to the closest gravity sewer or with soak pit with septic tank with necessary arrangements.

17. All staircases shall have granite non-skid tiles for treads and risers of approved make and shade and half tile skirting set in cement mortar in 1:4 to be provided. All concrete stairs shall have aluminium nosing over 2 mm thick rubber strip of width same as nosing for the full length of the tread. Nosing shall be fixed with countersunk screws.

18. Stairways shall be provided to permit access between different levels within buildings. Staircase shall be minimum 1200mm wide, minimum Tread = 250 mm, maximum Riser =175 mm and maximum 15 number of steps per flight unless specified otherwise. Staircases in general shall not be steeper than 40°. The maximum vertical run for a single flight of stairs shall be 3.0 M.

19. All roof tops and overheadtanks shall be made accessible with ladder provision.Vertical step ladders fitted with landing point extensions shall be permitted where considered appropriate by the Engineer to access areas not frequently visited. Steel staircases shall be constructed of standard channel stringers with M.S. grating treads 25mm thick with non-skid nosing. Steel Ladders shall be minimum 600mm wide and shall not exceed 6m of straight and shall be painted with epoxy paint. PVC encapsulated Cast Iron rungs or step shall be provided on the inner side walls of all the liquid retaining structures at 300mm spacing.

20. All hand railing shall be provided with Aluminum Extrusion tubes having alloy AA6082 Temper T6 or AA 6063 T6 with an ultimate tensile strength of at least 207 MPa and yield strength of at least 172 MPa. The minimum height of hand railing shall be 1m and maximum spacing of verticals shall be 1.5 m (32NB)- Number of horizontal rails shall be 3 (1 top-32 NB, 1 intermediate- 25NB and 1 bottom- 25NB) with a 100 x 2.5 toe plate at the bottom.

21. The reinforced concrete roofs shall be made waterproof by application of an approved roof polythene / bitumen membrane brick bat coba/ Yelahanka tiles. The finished roof surface shall have adequate slope to drain quickly the rain water to R.W down take inlet points.

22. All roof floors shall have minimum 750 mm height solid concrete block parapet wall where accessible is provided and shall have minimum 300 mm height solid concrete block parapet wall where accessible is not provided.

23. For roofing drainage, uPVC 6kg/sqm rainwater down takes with Bell mouth and uPVC gratingat top shall be provided. For roof areas up to 40

sqm minimum two nos. 110 mm diameter down take pipes shall be provided. For every additional area of 40 sqm or part thereof, at least one no. 110 mm dia. down take pipe shall be provided.

24. Top surfaces of chajjas and canopies shall be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rain water. All chajjas and canopies shall be provided with drip moulding.

25. Building plinth shall be minimum 500 mm above average finished ground level around building. Damp proof course shall be minimum 75mm thick in cc 1:3:6.

26. All doors, windows, rolling shutters shall have lintels above. Chajja protection to lintels on external walls shall be such as to prevent the rain water splashing into the building. Chajja projection of minimum 750 mm for rolling shutters, 600 mm for doors and 600 mm for windows shall be provided to prevent the rain water splashing into the building. Chajja shall be projected 150 mm on either side from size of doors/windows/rolling shutters.

27. All windows and ventilators shall have 25 mm thick Bull nosed Granite stone sills bedded in cement mortar (1:3).

28. Alldoors,windowsandventilatorsshall be made ofaluminiumconfirmingtolatest versionofIS: 1948. All fixtures for doors, windows and ventilators shall also be of aluminium and shall be provided as per IS specifications. Aluminium grills shall be provided in all the windows. Doors shall be in two panel and both panels shall be glazed/unglazed. Minimum weight of aluminium doors & windows shall be as follows:

I. SingleGlazedWindow:(Weightsindicatedshallbealuminium)

a) Openable

Outer Frame : Weight 0.70 kg/Rmt Shutter Frame : Weight 0.97 kg/Rmt Intermediate Mullion: Weight 0.97kg/Rmt Beading : Weight 0.31 kg/Rmt

FixingLouverswindows/ventilators
OuterFrame : Weight0.46 kg/Rmt

II. DoubleGlazedWindow

Outer Frame : Weight 0.72 kg/Rmt Shutter Frame : Weight 0.97 kg/Rmt Intermediate Mullion: Weight 0.98kg/Rmt Beading : Weight 0.31 kg/Rmt

III. SlidingWindows

Bottom & Top Frame : Weight0.70kg/m
Shutter Frame : Weight0.42kg/m
InterlockingSection: Weight0.47kg/m

IV. AluminiumDoor

Outer Frame : Weight2.508kg/Rmt

Shutter Frame : Weight 2.508 kg/Rmt BottomStile : Weight2.508kg/Rmt

Glazingshallbe5.5wiredmmthickglass.asperIS:2835fordoorsand windows. Glass louvers shall be provided for ventilators with frame weight of 0.46kg/Rmt

29. Openingsofthewindows&ventilatorsshallbeminimum25%oftheexternalwallarea.

30. Ventilatorshallalsobeprovidedwhereheightoffloorismorethan 3m.

31. All windows and ventilatorsshall have wire mesh. Frame of doors, windows and ventilators shall be of aluminium of standard rolled section. Doors, Windows and Ventilators shall be of size as per schedule to be submitted by the Contractor for approval of Engineer. The minimum sizeshall be as per below:

Doorofopeningsize1.2mx 2.1m

Door of opening size 0.75m x 2.1m for

toilets

Glazedwindowsofminimumsize1.2mx1.

2m Ventilators of minimum size 0.6m

x 0.6m

32. Rolling shutters shall be made of 80 x 1.25 mm MS laths. Rolling shutter shall be of minimumsize 3m wide x 3.0m high. Rolling shutter shall be provided in MCC cum panel room, chlorine tonner shed, and centrifuge at entry and exit of the pump house for access to pumps, motors, valves, panels, blowers and as wherever required. Up to 3m height mechanical operated rolling shutter shall be provided and If the height is more than 3m, then electrically operated rolling shutter shall be provided.

33. All structural steel members shall be painted with two coats of enamel paint over one shopand one field coat of red oxide zinc chrome primer. All concrete channels and ducts used for conveyingliquid shall have inside finish of type F2.The width of concrete channels shall not be less than 500 mm. All open channels shall be provided with Aluminium hand railings.

34. Allexposedsurfaceofinsertsembeddedinconcreteshallbepaintedwithtwocoatsofenamel paint over one coat of Red Oxide Zinc Chrome Primer. Surface in contact with concrete shall not be painted.

35. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factory Act. It shall not be less than 150mm.

36. All structures in the ISPS and Treatment plant units shall be provided with appropriate sign boards indicating the function of the units involved written in Kannada and English Languages.

37. Wherever equipment and machinery are to be moved for inspection, servicing, replacement etc., suitable movable gantry of minimum capacity of 2 tonnes or more as required shall be provided with monorail and operating equipment.

38. The design of buildings shall reflect the climatic conditions existing on site. Process buildingsshall as far as is possible permit the entry of natural light, and the use ofglazed panelling shall be kept to a minimum and preference given to wallopeningsprotectedby weathercanopies.

39. Emergency exit doorways shall be provided from all buildings in order to comply with local and international regulations. Stairways and paved areas shall be provided at the exit points.

40. Toilet blocks in process buildings and control blocks shall be provided with a sink with two drinking water taps of 20 mm size with adequate inlet and outlet connections.

41. The side walls of buildings shall, except those used for storage and handling of Chlorine gas comprise at least 15% ventilated brickwork or louvers.Ventilated brickwork or louvers shallnot be used where the ingress of driven rain could affect plant or stored materials.Flat roofed areas shall be provided with roof vents to further encourage a through flow of air.

42. All the walkways shall have minimum 1.0 m width and shall be secured with Handrails and toe guards.

43. SuitableRiverflowtrainingsystems/ Flowdiversiontobeadoptedatrequiredlocations/places in compliance with relevant Geotechnical Investigation Report recommendations as applicable.

44. All concrete structures in contact with sewage and/or sludge shall be provided with full interior corrosion protection linings and/or coatings of appropriate material and thickness tobe approved by Employer. For Aeration Basins, interior lining shall extend from the top of wall down to 1.0 meter below the lowest operating water level.

45. For structures containing water or process liquid, the top of the wall shall be at least 0.5m higher than the maximum water surface level calculated at high flood level and peak plant flow. The top level of internal plant roads and approaches shall be at least 1.0 m above thesite High Flood Level.

46. If the High flood level is more than Ground Level, then road shall be constructed on the Earthen Embankments/Engineered Embankment. Earthen Embankments/ Engineered Embankment shall be constructed with side slope of at least 2 horizontal to 1 vertical. Stone pitching shall be provided at both sides of the embankment as per IS: 8237. Top width of embankment shall be taken as 6.0m. Top level of embankment shall be 1.0 m above high flood level. The excavated earth from the plant can be used for earthern embankment construction if suitable and if required extra earth can be borrowed from the borrow pit as approved by Engineer.

47. Anti-termite treatment, under and around the column pits, walls, trenches, basement excavation, top surface of the plinth filling, junction of wall and floor, along the external perimeter of building, expansion joints, over the top surface of consolidated earth on which apron is to be laid, surrounding of pipes & conduits, with chloropyriphos emulsifiable concentrates of 20% concentration is to be provided for this onlyplinth area of the buildingat ground floor only shall be measured.

48. Engineered Embankment for plant structure in Swampy/Water logged areas shall be considering in compliance with relevant Geotechnical Investigation Report recommendations as applicable.

49. All requirements for Engineered Embankment and all other associated works connected tothis system (i.e. all controlled filling requirements, type & suitability of materials, methodologies testing, protective system, aprons, proper slopes, stability, specifications, quality control, and all other requirements pertaining to this system of works, etc.,) shall be considered in compliance with relevant geotechnical investigation report recommendation as applicable. Also, to enlist the service of an experience and specialized agency for all related designaspect consideration,equipment specifications,andimplementationmethodology,etc., as an advice for the same.

50. MS Chequered plates are not allowed in this contract. Only Aluminium chequered plates of alloy 3105 shall be used wherever necessary. It shall be of minimum 6mm thick and shall be supported with suitable PVC encapsulated MS structural members to handle the loads above the plates. Equipment load above the chequered plates shall be considered as 10KN/Sq m.The fixtures used shall be of SS. The Aluminium plates shall be in accordance with IS737.

Roadways, Pathways &Hard standings

Acomprehensivenetworkof roadwayswithturningbaysasrequiredforaccess,removalofplantand equipment, removal of sludge, grit etc. Fromsite shall be provided around the treatment plant to link in with the existing road network and permit access to the plant for necessary maintenance, delivery of consumables and personnel access.

All roads shall be designed and constructed as per the specifications and as per site requirements. Bidder shall provide minimum 3.5 m wide internal roads with 1.50m shoulder on one side, which shall be utilised for future expansion of the internal road and 5.0 m wide approach road shall be provideduntilSTPEntrygatefromthenearbyMainRoadorHighway.1.5mshouldero nbothsides of the road shall be provided as per site requirement and as directed.

TheroadworksshallbedesignedandconstructedasperMORTHguidelinesandspeci fications.The minimumroad layers shall consist of granular sub base, sub grade, wet mix macadam(2 layers with compacted thickness of 150 mm), semi dense bituminous concrete, bituminous macadam and Bituminous concrete as per the design requirements All roads shall be provided with drainage and shall be constructed to prevent standing water.

Paved pedestrian access ways shall be constructed to provide a network of logical routes interlinking plant areas. Damage to any existing roads on account of their use by the Contractor shall be made good to the satisfaction of the Engineer.

Hard standing areas with shading facility shall be provided to permit the parking of vehicles involved in the delivery of consumables from blocking site roadways during unloading or loading. The road system shall be designed such that vehicles involved in the delivery of consumables can follow a continuous route through the works and out again without the need to reverse or carryout complicated maneuvers in order to exit the site.

Site Drainage

TheContractorshallprovideasitedrainagesystem.Thesystemshallcompriseofthefollowing:

- StormWaterDrainage
- Foul Drainage
- ProcessDrainage

StormWater Drainage

For the major stormwaterdrains passingbesides or withinthe STPcomplex shallbe designed asper CPHEERequirementsconsideringthecontributingcatchmentarea.Necessarycrossdrainageworks shall beprovidedforroadcrossingetc.Iftheexistingstormwaterdrainispassingthroughthecenter of the STP area, the storm water drainage alignment shall be diverted along the edge of the STP complex area for proper usage of the STP area.

For the internal storm water drains adjacent to the existing and proposed roads (under the contract) shall be sized for a rainfall intensity of 50 mm/hr, allowing for 100% run off. The drains adjacent to roads for walls and floor shall be in RCC M 20 grade. The floor is to be laid over a minimum thicknessof10cmthick1:3:6PCCbedandthedrainistobecoveredwithM25gradeRCC slab.The minimumwidthofthedrainshall be300mm.Thestormwater drainagesystemshall alsobedesigned to cater the run off from the existing plot areas and structures, if necessary depending upon the site topography.

FoulDrainage

The foul drainage system shall accept discharge from toilets, washrooms, offices and the laboratory. The foul drainage system shall discharge to a septic tank of appropriate volume or to the existing foul drainage system.

FloodProtectionWorks

An Earthen Embankment with minimumslope of at least 2 horizontal to1 vertical on bothsides has to be constructed as required. Slope of the embankment shall be decided as per the soil properties.

Stonepitchingshallbeprovidedonthebothsidesoftheembankmentasper IS:8237 .Topwidth

oftheembankmentshallbeatleast3.5m.Toplevelotheembankmentshallbe587.5.Embankment shall be designed as per IS: 12094.

Earth for the embankment & site grading shall be made available from the contract package of the same project. Excavated earth from Reservoir and pumping station proposed to be constructed as per the contract shall be used for the construction of earthen embankment and site grading. If required, excavatedearthfromtreatmentplantshallalsobeusedforearthenembankmentandsitegrading.The embankment shall be constructed with the available material as per the standard specification.

GIchainlinkfencingshallbe2.75mhighabovefinishedgroundlevel withtop0.75metreofbarbed wire confirming to IS 278.The fencing shall include fabric mesh confirming to IS 2721, top and bottom runner wires, vertical posts, GI strap at every vertical post, etc, all as approved by the Engineer.

Cableand Pipework Trenches

Cableandpipeworktrenchesshallgenerallybeconstructedinreinforced concrete.

Trenches within the buildings or Plant areas shall be covered with M20 precast R.C.C covers. The trenches shall be suitably sloped to drain rain water. All uncovered openings shall be protected with hand railing

Layout of trenches outside the buildings shall allow space for construction of future trenches where necessarywithdueconsiderationforplanningforfuture developments.Thisaspectshallbebroughtto the notice of the Engineer while planning the works.

PipesandDucts

R.C.Cducts for drainage shall have minimum1 meter over precast cover (M20 concrete, Heavyduty) while laid under roads. Access shafts of size not less than 600 mm x 1000 mm shall be provided.

All drains (except storm water drains adjacent to roads) shall be covered with precast RCC slab and designed structurally for appropriate loads.

PrecastCompoundWallandGate

CompoundwallshallconsistofRCprecastslabpanels(M25)withminimum60mthicknessBWSSB logo, RC post at regular intervals including plinth beam as supports for the panels and necessary RC foundationsystemforthesamealongwithbarbedwirestretchedbetweenMSanglesfixingat thetop of the precast panels with necessary fixtures etc.,

AllstructuraldesignsandSpecificationsshallconfirmtorelevantcodalprovisions.

AnIndicativeTypicalBoundarywallprofileofTYPE-I&TYPE-IIisenclosedasreferenceforthe same. (Refer to Sketch -1, appended in Page 32 & 33)

Each proposed ISPS and Sewage Treatment plant shall have one main gate to access the plant irrespective of existing gate at the premises of existing plant site. Minimum clear width of main gate shall be 6m. Main gate shall have 1.5m wide wicket gate. Gates shall have as external framework of GI pipes and internal framework of MS flats. Gate shall be fixed on RCC columns. The design and pattern of gate with drawing shall be submitted for approval of the Engineer. The gate shall have all necessary hinges, locking arrangement, rolling arrangement and painting complete, as approved bythe Engineer.

Retainingwall

1. Retaining wall shall be RCC with minimum M25 grade of concrete. Wall foundation shall be placed onvirgin soil and not onbackfill soil. Foundation shallextendtoadepth of at least 1.0 meter below finished ground level or as required

2. Expansionjointsshallbeprovidedintheretainingwall.

3. In retaining walls, 100mm dia weep holes shall be provided at 1m vertically and horizontally. The lowest weep hole shall be about 30cm above the ground level. All weep holes shall be surrounded by loose stones and shall have sufficient fall to drain out the water quickly.

Landscaping

The site shall be landscaped once the Works are substantially complete. Landscaping area shall be marked in layout plan.

Landscaping shall include planting of suitable trees and development of grassed areas.Landscaping in general shall meet ecological and environmental conditions of the site.Road widths shall determine the size of the tree height and spread to be selected for planting.Trees suitable for local conditions shall be selected.Medicinal and fruit trees shall be avoided. Landscaping shall be maintained in good condition till the completion of contract. Area for landscaping shall be equal to total area of project site minus area forthe ISPS/Treatment plant units and the area required for roads, sidewalks and drains.

1.30.1.Tree Planting

Pits dug a few days in advance of actual planting shall be allowed to weather

and be filled with top soil mixed with manure.Size of the pit shall be as per standard requirement.Only one tree shall be planted in each pit.A guard made of bamboo with wire mesh or bricks or M.S. rings as approved by Engineershallbeprovided.Aminimumof100treesshallbeplantedineachSTPlayouto ranyother

suitable location shown by Engineer. A minimum of 20 trees shall be planted in each ISPS site layout oranyothersuitablelocationshownbyEngineer.Alltreesshallbemaintaineduptotheendof O&M period.

HydraulicTestingofLiquidRetaining Structure

In addition to the structural test of structures as applicable, the liquid retaining structures shall also be testedfor watertightnesstestatfullsupplylevelasdescribedinclauses 12.1,12.1.1, 12.1.2and12.1.3 of latest version of IS 3370 (Part I).

On completion of the structure and before its commissioning, the contractor shall carry out a water tightness test for the maximum water head condition i.e. with the water standing at Full Supply Level (FSL) of the structure. This test shall be carried out preferably in dry season in accordance with the procedure given below:

The water tightness test shall be carried out when the construction of liquid retaining structure is completed and when it is possible to fill the structure and ensure that uniform settlement of the structure as a whole or as directed by the Engineer. Before the filling operations are started the structure shall be inspected by the Engineer and the Contractor's Representative and the condition of surfaces of walls, contraction joints shall be noted and it shall be ensured that the jointing material filled in the joint is in position and all openings are closed. The Contractor shall make necessary arrangement for ventilation and lighting of the structure by way of floodlights, circulators etc. for carrying out proper inspection of the surfaces and inner conditions if so desired by the Employer. Records of leakages starting at different levels of water in the reservoir, if any, shall be kept.

The liquid retaining structure once filled shall be allowed to remain so for a period of seven days before any readings of drop in water level are recorded. The level of the water shall be recorded against the subsequent intervals of 24 hours over a period of seven days. The total drop in surfacelevel over aperiodof seven days shall be taken as anindication of the watertightness of the structure, which for all practical purposes shall not exceed 20 mm excluding evaporation loss. Also there shall be no indications of the leakages around the opening or on the walls.

Ifthestructuredoesnot satisfytheconditionoftest andthedailydropinwaterlevel isdecreasing,the period of test may be extended for a further period of seven days and it the specified limit is then reached the structure may be considered as satisfactory.

The external faces of structure shall not show any signs of leakage and shall remain apparently dry over the period of observation of seven days after allowing a seven day period for absorption after filling.

In case the drop in level exceeds the permissible level limit and signs of leakage with the stipulated periodoftest,theContractorshallcarryoutsuchadditionalworksandadoptsuchmeasuresasmaybe directed by the Engineer to reduce the leakage within the permissible limits. The entire rectification workthatshall be carried out inthis connection shall be atthe Contractor's cost. Contractor shall have to make arrangement for filling emptying the structure at his own cost.

If the test results are unsatisfactory, the Contractor shall ascertain the cause and make all necessary repairs and repeat the liquid retaining structures test procedures, at his own cost. Should the re-test results still be unsatisfactory after the repairs, the structure shall be condemned and the Contractor shall dismantle and reconstruct the structure, to the original specification, at his own cost.

During testing and during defect liability period the impression marks created due to seepage shall be rectified and made good.

No separate payment shall be made for water tightness test and the cost thereof shall deem to be covered in the rates quoted for the works.

Non-DestructiveTestingof RCC Structures

Non-DestructiveTesting(NDT)shallbecarriedoutasperlatestIS:13311codesasperthe instruction given by Employer.

CommonlyusedNDTtofindquality,structuralintegrityandsoundnessofinsituconcreteare:

1. ReboundHammerTestisaqualitativefieldtestmethodtomeasuresurfacehard nessof concrete to find insitu concrete strength.

2. Ultrasonic Pulse Velocity (UPV) Test is a qualitative field test method for determination ofdiscontinuities, cracks and depth of cracks of concrete.

3. Core cutting/Sampling Test is a field cum lab test for assessment of strength, density, texture and permeability of concrete.

4. Radiography Test for taking photographs showing details inside of concrete member, where other NDT methods are not suitable.

5. ImpactEchoTestisafiled/laboratorytestmethodtodetecthiddendamageanditsextent.

In case there is any distress in concrete during the execution, Engineer can take decision to go for NDTontheRCCconstructionbeforetakinganyaction.ContractorshallconductNDTt estsonhis own cost.

SpecificationforAnti-CorrosiveInternalCoating/ LiningprotectionofConcrete Surfaces

ApplicationlimitsofAnti-CorrosionInternalCoating/LiningforConcreteSurfaces:

1. All units upstream of secondary treatment units shall have to be provided with internal coating/lining for the full internal surface area (Walls and base slab).

2. For the units - Anaerobic Zone, Anoxic Zones, Aeration Zones and Aeration Basin Effluent Channels, internal coating/lining shall be provided on the walls only from the top of the structure to 1.0 m below the lowest operating liquid level

3. For the units handling the solids part such as Sludge Thickener, and all other units, internal lining shall to be provided for the entire internal surface area.

Contractor shall adopt any one of the following materials for internal coating/lining which should be grey coloured, **solvent free**, machine sprayed, resistant to water and chemicals, good bond between concretesurfaceandlining/coatingmaterialandsubmithismethodologyforapproval ofEngineer. no signs of swelling, scratches or peeling of coating specimen shall be observed after application of coating or lining.

ConcreteStructure-
Surfacesmustbeclean,dryandfreefromcuringcompounds,laitance,releasing compounds, oil, grease, dirt, chalk, or previously applied coatings. Laitance must, therefore, be removed by sweep blasting or other means prior to coatings application. Ensure that the concrete is sufficientlydrytoreceivecoatings;useamoisturemeter.The6%maximummoistureco ntentshallbe permissible. a minimum surface thickness of 500 microns is recommended.

SteelStructures-
Allsurfacestobecoatedmustbecleanandfreefromdust,grease,oilorloose material. a minimum surface profile of 50- 75 microns is recommended.

Belowaresomeofthevendorproductsaccepted.However,theprocessandapplication requirements shall be matched and got approved from the engineer in charge before start of work for the products and vendors mentioned below. Also, if any new material and vendor can meet the process

requirements,asstatedabove,theEngineerinchargeshall approvethematerialspecificationsbythe manufacturer.

Sl No	ApprovedVendor	Approved/ Appropriateproduct
1	SikaIndiaPvt.Ltd.	IntertolPoxitor
2	STPLimited	Shalipoxy–CTE406
3	BASFConstructionchemicals	MasterSeal– 7000CR
4	Fosroc	NitocoteNT402
5	International-PC	Interzone 954

RainWaterHarvesting System

TheRainwaterharvestingfortheproposedSTP&ISPScomplexshallbecarriedoutinli newiththe regulatory guidelines specified by Bangalore Water Supply and Sewerage Board (BWSSB) & GOK norms.

Componentsof theRain waterHarvestingscheme

1. Rainwaterharvestingcarriedoutforenrichingthegroundwaterresourcesessentiallyconsist
    a) Commoncollectiontankand
    b) Pipeline(s)

2. Following are the main components proposed for the roof water harvesting systemat the STP including their location in the project area:
    a) Rainwaterpipesfromtheroofsofallthebuilding.
    b) Firstflushpipingsystem.
    c) Stormwaterdrainsadjoiningtheroadsoftheplant.

Rainwaterharvestingsystemfor buildings

The run off from the roof top of all buildings shall be collected to a RCC sump at suitable location in the plan area with a minimum water retaining capacity of 40Cum. The minimum height of the sump shall not be less than 1.8m and 0.3 m free board The runoff shall pass through suitable filters for removalofimpurities.Asuitablesubmersiblepumpshallbeprovidedinthesumpforsu pplyingwater to gardening and flushing the toilets, to reduce use of potable water.

Rainwaterharvestingsystemforplantarea

Therunofffrominternalroadsidedrainandmajorplantareshallbedrainedtorainwaterharvesting structures for ground water recharge.

WellSinking

The Well Sinking shall be proposed for Wet wells, where the surrounding area is in water logged conditionorwatertableisuptoFGLanditisdifficultforopenfoundations.WellSinkingshallbe done as per specificationsmentionedin Part-10A andshall meet the requirementsas mentioned in Part-1, additional scope details for civil works under works –A.

Gabion

General

AGabionisawirecagethatcanbestackedverticallyinawallandthenpackedwithroughstonesand normally used as retaining walls. The Gabions protect slopes and stream banks from the erosiveforces of moving water.This bund should keep the construction area dry and free from flood waters. It should be envisaged to provide firm bank protection, for the construction of STP/ISPS. The requirement of Gabion wall is mentioned in Part-1, additional scope details for civil works under works-A.

Specification

Gabionsarecompartmentedrectangularcontainersmadeofheavilygalvanisedsteelwire,filledwith stones, the gabion becomes a large, flexible and permeable building block. Gabions comprises of welded wire mesh panels accurately cut to size with heavy section wire spirals used for interconnecting the edges. The meshes and spirals are pre-galvanized with zinc coating of 450 gram per sqm. Gabion shall be confirming to ASTM-A974 (Standard Specifications for Welded Wire Fabric Gabions and Gabion Mattresses).

Gabion shall be provided up to site FGL. Top width of gabion at FGL shall be minimum 1.0m the bottom of the gabion shall be projected minimum 1.0 m below the natural Ground level with 300mm rubblesolingbelowthebaseasalevellingcourse.Theboldersusedingabionshallbehardandshall not deteriorate under water. The sections shall be worked out considering 10% porosity with a depth of 1m below the ground to the top level

and boulder size shall not exceed 200mm.

Stabilityofthegabionwallunderstaticconditionandpossibleseismicloadingshallbeensuredforits long-term performance and Stability analysis shall be carried out in accordance with IRC -89 and relevant codes.

LayingWireCratesandMattresses

Wire crates shall be made from PVC coated hot dipped galvanized mild steel wire of diameter not lessthan 4 mmin annealedcondition havingtensile strength of 300-450 MPa conformingto IS: 280. Thegalvanizingcoatingshallbeheavycoatingforsoftconditionconformingto IS:4826.Furtherfor design purposes the contractor shall take into account the requirements of the following BIS codes also –

IS16013~WeldedWireGabions(metallic-coatedormetallic-coatedwithPVCcoating).

IS 16014~Mechanically woven, double -twisted, hexagonal Wire Mesh Gabions, Rivet MattressesandRockfallNetting(GalvanizedsteelwireorGalvanizedsteelwore withPVC coating)

Themeshofthecrateshallnotbemorethan150mm.Wherethesehavetobedepositedandthereisa chance of overturning, the crate shall be divided into 1.5 m compartments by cross netting.

For deep or inaccessible situations, wire crates can be made smaller subject to the approval of the Engineer.Wirecratesbuiltin-situ,shall not belarger than7.5mx3mx0.6 mnorsmallerthan2mx 1 m x 0.3 m. Sides of large crates shall be securely stayed at intervals of not more than 1 .50 m to prevent bulging. The Contractor shall design and submit all designs, drawings, method statements, material submittals, Quality Assurance Plans required for the construction of the Gabion structures to the Engineer-in-Charge.

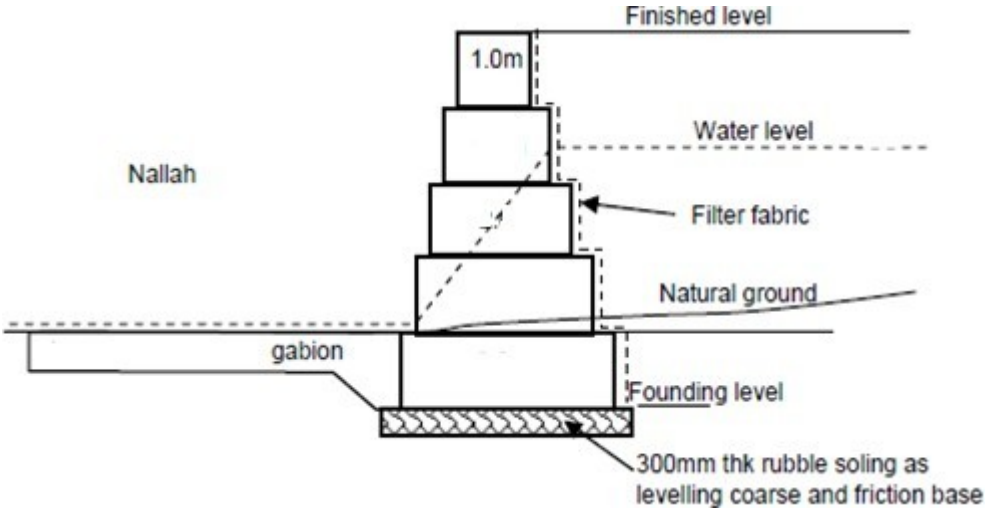


Figure:TYPICALSECTIONOFGABIONWALL

Pile Foundations

General

The design of Pile foundation shall be in accordance with IS: 2911- Bored cast in-situ piles with minimumgrade of M30.Where it is anticipated to fillthelow lyingSTP/ISPS areastoa depth of 2m to 5m (Engineered fill), water logged areas, soft soils, low SBC areas, it is practically difficult to provide shallow foundation, hence pilefoundationis proposedinthose areas.The requirement of Pile FoundationsismentionedinPart-1,additionalscopedetailsforcivilworksunderworks-A.Hencethe bidder shall follow the same philosophy for pile foundations.

Wheresitefillingisenvisaged,
Insuchcasestheproposedsiteshallbefilledandcompacteduptothe FGL with proper consolidation and site filling methodology and later the pile construction activities shall be taken up. Below points are to be taken care

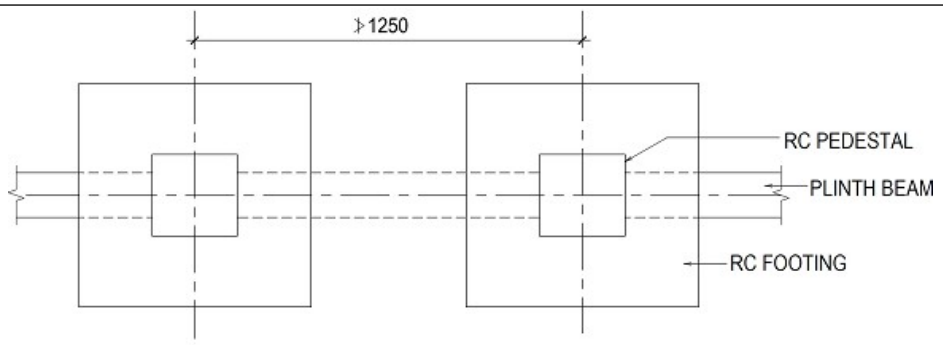
i. Beforetheactualconstructionbegins,pileloadtestsmust be madeto verifythedesign values, the foundation design must be revised according to the test results.

ii. Piles in sands are driven to the maximum possible depth because pile load is proportional to square ofthelength. In clayeysoils, increasedlengthdoes not increasethecapacityas rapidly as in sandy soils. In clays the length is determined by block failure criterion. Provision of a spread or bulb at the bottom increases the pile load considerably.

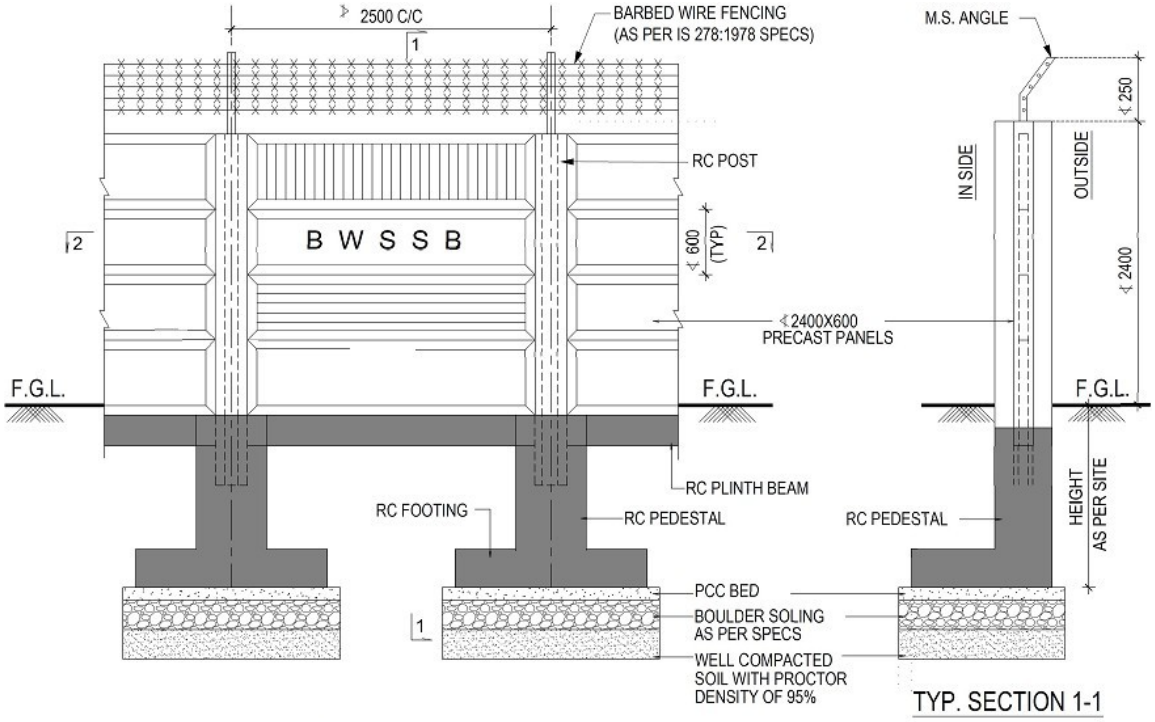
iii. A minimum of three piles are required under a column in order to resist all the column loads and moments acting on it. If one or two piles are provided under a column, the grade beams have to be provided in one or more directions which have to be designed to resist fullycolumn basements since piles shall resist the vertical loads only.

Compactionmethodology

TheEngineeredfillshallbeplacedinlayersofeachliftnotexceeding200mmthickwithappropriate confinement or self-stabilising slope at the edges. Rollers shall be adopted in order to achieve 97 % modified proctor density, with data for modified proctor density to be initially obtained from laboratory testing of fill material. The number of passes and rollers shall be as suggested in IS-4701(based on soil type). The Quality control tests shall be adopted to verify the achievement of required level of compaction prior to giving clearance for laying next layer. The soil intended for filling shall not have excessive presence of gravels, cobbles/silts and clays.

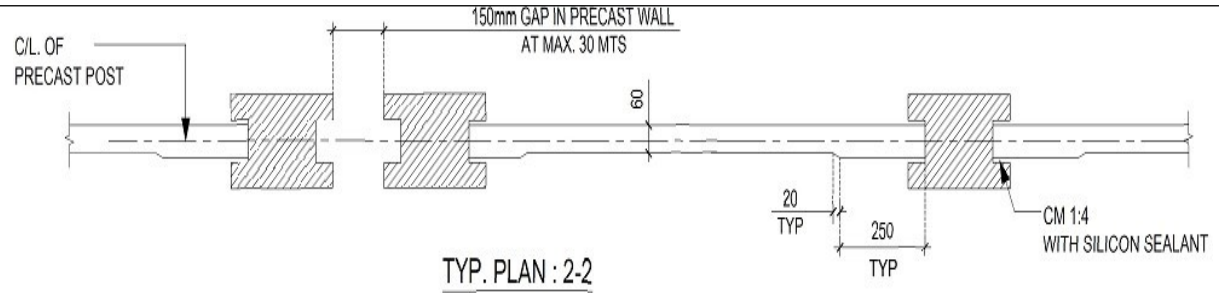


TYP. PART FOUNDATION PLAN

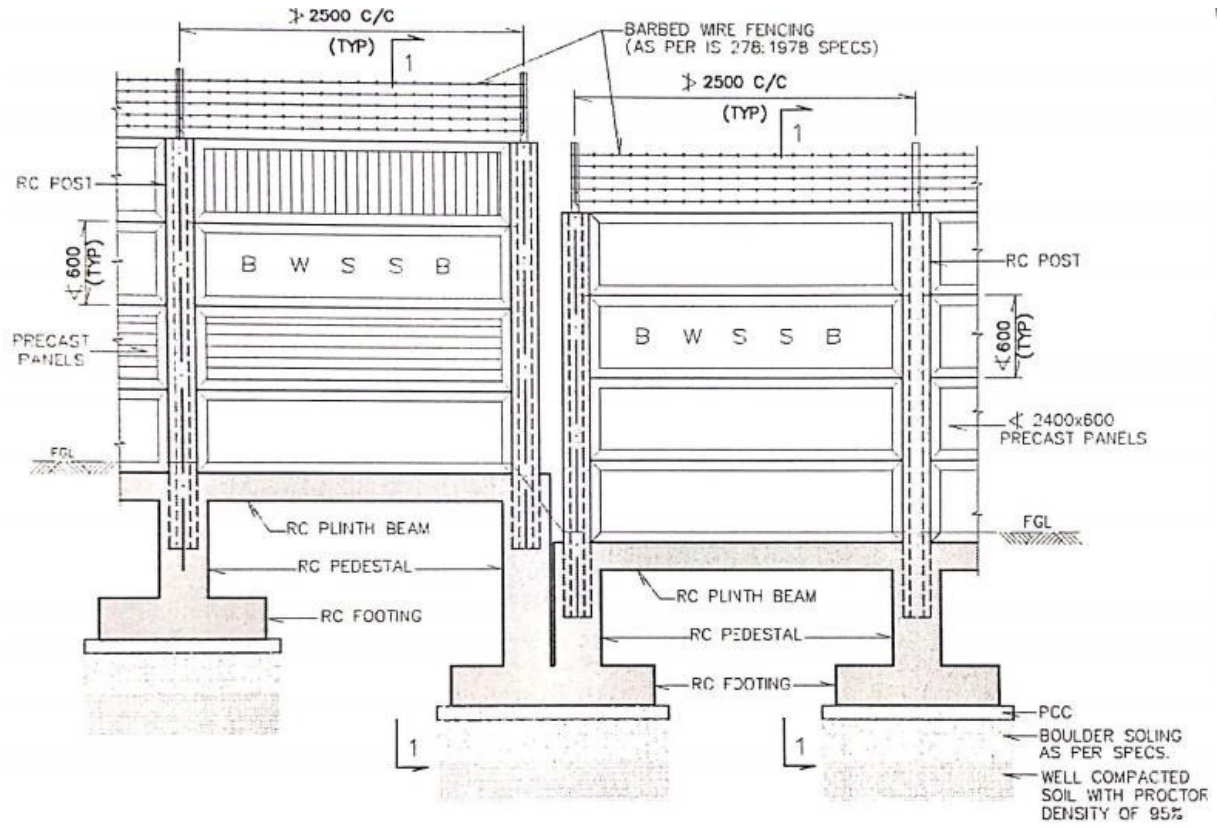


TYP. SECTION 1-1

TYP. PART SECTIONAL ELEVATION OF BOUNDARY WALL
AT UNIFORM GROUND PROFILE (TYPE - 1)


150mm GAP IN PRECAST WALL
AT MAX. 30 MTS
C/L. OF
PRECAST POST
60
20
TYP
250
TYP
CM 1:4
WITH SILICON SEALANT
TYP. PLAN : 2-2

SKETCH-1



TYP. PART SECTIONAL ELEVATION OF BOUNDARY WALL
AT VARYING GROUND PROFILE (TYPE–II)

SKETCH-2

C. ParticularTechnicalSpecificationsforPumpingmain/ SewerNetworkandAllied Works

SECTION – 1

EARTHWORK EXCAVATION

Clearingsiteoflargetrees,structures etc.

Thisshallincludetheremovaloflargetrees,stumps,structures,servicessuchascables ,watersupply, sewerage,stormwaterdrainsetc.orpartsthereoflyingalongthealignmentofsewer.T hecontractor shouldinformtheEngineerbeforeremovingtrees,structures,otherservicesandstruct uresetc.wellin advance.LargetreesandothervaluablesarethepropertyoftheGovernmentanditsho uldbeproperly stackedalongthesideoftheroadandconveyedtotheplaceasperdirectionsofthedepar tmental Engineer.Thecuttingoftreesordemolitionsofstructurearedoneinsuchawaythatitsh ouldnot disturb the traffic and pedestrians.

Removalof TopSoil,ShrubsandOther Vegetation

The work has to be tackled in between two adjacent manholes only. All shrubs, vegetation and other plants shall be removed and cleared from the selected stretch of the site. All debris and unsuitable material uptoadepthof30cmbetweengroundlevel androadlevelshallberemoved.All debrisand unsuitable material shall be carted away from the site as per the direction of departmental engineer. The clearing and grubbing for trees upto 300 mm girth shall be removed. No separate payment shall be paid towards the above works and work includes loading, unloading, carting the material to a site selected by the contractor, disposal of unserviceable materials at his own cost.

General

Excavationshallberequiredtobedoneforthefollowingworks:

e) Excavationsforundergroundsewerlines&pumpingmainsandotherworksasdirected
f) Excavationsforsewerlinesbelowstormwaterdrains
g) Excavationsformanholes,footings,pedestalsandotherworksasrequiredetc.
h) No separate payment shall be made for removal of shrubs, grass, large

and small bushes, trees, stumps and stems of trees cut up to 300 mm girth, fencing including posts and gatesand rate for the same shall be deemed to be included in the other pay items of BOQ

PreparatoryWork,Sight-railsandBoningStaves

The centre line of the trench is first marked out on the ground duly driving pegs at convenient intervals.Beforecommencementofearthworkexcavation,levelsshallbetakenalong thecentreline of the proposed sewer at intervals of say 10 m and at the manhole locations. A longitudinal section (LS) of the profile of the ground surface showing the proposed sewer, indicating the gradients and giving the invert levels of the sewer as well as the manholes available at the tender stage shall be updatedbasedonContractorsre-confirmatorysurveyandapproved bytheEngineerbeforetakingup the work.

Thewidthofthetrenchtobeexcavatedismarkedonbothsidesofthecentrelineandex cavation lines cut out.

Twowoodenposts100mmx100mmx1800mmhigh shallbefirmly,erected/fixedacrossthecentre line i.e on either side at nearly equal distance, from the centre line and sufficiently clear of allintended excavation such that the poles/posts are not disturbed during the course of execution of the work. These posts are so arranged and fixed that a sight-rail when fixed at a level against these posts shall cross the centre line of sewer or centre of the manhole, as the case may be.

Thesight-railmadefrom250mmwidex40mmthickwoodenplanksshallbescrewedtothepoles. Thesight-railsshallbetrulyhorizontal.Thecentrelineofthesewershallbemarkedonthesight-railby fixinganailorotherwiseasdeterminedbytheEngineer.Thesight-railsmaybe fixed about 1.25 m above the ground, which is convenient distance for sighting by a leveling instrument. The sight-rails have to be so fixed that when a line sighted along the top edge of the sight-rails shall represent the true fall or gradient of the proposed sewer. This gradient is transferred below the ground level by means of boning-rod. Boning is carried out between the sight-rails with the help of a cord or a rope extended from nail to nail fixed on the sight-rails.

Boningrodswithcrosssection75x50mmofvariouslengthsshallbepreparedwithwood .Eachlength shallbeacertainnumberofmetersandshallhavefixedtee-head. (Acrosspieceof450x100mmisto befixedwithnailsatthetopoftheboningrodsoastoformshapelikeaTee-square)andacrosspiece about300mmlongfixedatthebottomoftheboningstaff.ThedistancebetweenthetopofTeeheadand thecrosspieceshalldependuponthesiterequirementsviz,diaofpipe,depthofcutting,levelofsight-rail,designedlevelofsewer,etc.Theboningrodmustbemarkedontwosidestoindicateitsfulllength. Accordingtothecircumstancesofeachcase,asuitablelengthofboningrod,dulyfixingthecrosspiece,

willbedetermineduponthereducedleveloftheinvertofpipeateachsight-rail.

Thesight-railandverticalpostsshallbeperfectlysquareandplanedsmoothonallsidesandedges. Thisarrangementoferectingpoleswithsight-railshallbedoneatsuitableintervalsdependingonthesiterequirements,asdirectedbytheEngineer.Thepostsandrailsmustinnocaseberemoveduntilthetrenchisexcavated,thepipesarelaidandpermissiongiventoproceedwiththefillingin.

ProbingPits

Beforestartingtheexcavationoftrenches,thecontractorshalldigprobingpitsofsize1mx1mand m deep including road cutting at every 100 m interval along the alignment to accurately locate and determine the position of existing utilities and obstructions. The contractor shall refill the probing pits in layers of 15 cm with excavated earth up to the original ground level. In all cases the probingpits are to be excavated in accordance withthe specification for excavation, refillingetc. No separatepaymentwillbemadefortheseprobingpitsandshallbedeemedtobeincludedinotherpay items of the BOQ.

UtilitiesProtection

Allutilitieswithinthesite,suchaswater,stormandsewage mains,shallbeascertainedbyprobing pit results at various intervals or as required.

All utility lines and structures, whether indicated on the drawings or not, which are to remain in serviceshallbeprotectedbythecontractorfromanydamagelikelytoresultfromhisoperations.Any damage to any utility resulting from the contractor's operations shall be repaired at the contractor's expense.

PavementRemoval

ThecontractormustinformtheEngineerbeforethestartingofworkwellinadvancesothatitcanbe communicatedtootherconcerneddepartments.Thecontractormustprovideandmaintainproperand efficienttrafficcontrolsystemsuchassafetylamps,signboardsetc.operatingdayandnightforthefull durationofwork.TheBWSSBshallnotberesponsibleunderanycircumstancesforanymishappenings therefore.Forthepurposeofpaymentofremovalofpavement,steeltapesaretobeused andthe measurementshallbetakenjointlybytheEngineer'srepresentativeandcontractor orhisrepresentative.
Themaximumwidthoftrenchexcavationshallasperrelevant Indianstandardsorouterdiaofthepipe+
0.3 mwhicheverislower and only such widths shall be taken into account for computing quantities for payment. For other elements of work such as manholes, making cross connections, fixing other appurtenancesetc.theengineershallprescribethedimensionsforremovalofpavementfromtimeto time.

Maintenanceof TrafficANDClosingofStreets

The work shall be carried out in such a manner which will cause the least interruption to traffic, and theroad/streetmaybeclosedinsuchamannerthatitcausestheleastinterruptiontotraffic,Whereit is necessary for traffic to cross open trenches, suitable bridges shall be provided. Suitable signs indicating that a street is closed shall be placed and necessary detour signs for the proper maintenance of traffic shall be provided.

Soil Investigations

Soil analysis reports of proposed sewer alignment are available with BWSSB office. Additional soil tests if necessary shall be carried out along the alignment and the soil boring logs shall be prepared bythecontractorathisowncost.Whereoff-sitematerialshavetobeused,thecontractorshall,ifthe Engineer desires make available certified soil test reports including information regarding sieve analysis, plastic limit, liquid limit, maximum density, optimum moisture content etc. from an approved testing laboratory.

Classification

Theexcavationworkshallbeclassifiedintothefollowingcategories:

Sewerlines,Manholes,pedestalsand otherworks.

iii) All soils: Loamy, clayey soils like BC soils, red earth, ordinary gravels, hard gravel, mixture of gravel and soft disintegrated rock, ordinary gravel, stony earth and earth mixed with boulders of 30 cms size and exclusive of disintegrated rock.

iv) Disintegratedrock, softrock, softshale,and mediumhardrockcomprisingoflime stone , sand stone, hard shale schiest, fissured rock or soft rock or conglomerate rock, to be removedbypickaxesandcrowbars,wedgesandhammerswithsomedifficultyincluding all types of laterite excluding hard rock

v) Hardrocktoberemovedonlybychiselingandbenching/breaker,diamondrocpecuttingor as directed by the engineer.

TrenchExcavation

General

Trenchexcavationmeansexcavationoftrenchesintowhichthepipeistobelaid.Thelineandlevelsof trenchesshallbeasshownonthedrawingsorasmaybedirectedbytheEngineer.Before commencing trench excavation, the route of the trenches shall be pegged out accurately and the natural ground levels shall be agreed with the Engineer.

Width of Trench

Thewidth oftrenches measuredatthecrown of the pipe shall permit adequate

workingspace.The trenchesshallbewidenedatsocketsandotherstructuresasmaybefoundnecessary. Thewidthsto be adopted are shown in respective drawings. If the widths of actual excavation are more than the specified, it has to be made by the contractor with no separate payment. Care should be taken to

avoidexcessivetrenchwidthsandtherebyincreasingtheloadonthepipes.Themaximumwidthof trenchexcavationshallasperrelevantIndianstandardsforpipelayingorouterdiaofthepipe+0.3m whicheverislower and only such widths shall be taken into account for computing quantities for payment. However, the minimum width of the trench shall be 600 mm.

Depthof ExcavationofTrench

The depths for the trenches will be calculated from the surface to the bed of the pipes and in case when a layer of bedding is to be placed below the pipe line, the depth to the bottom of the bedding willbepaid.Thedepthofexcavationformanholesshallbemeasuredfromthesurfaceoftheexisting ground level to the bottom of foundation. No payment will be given beyond this depth.

MaximumLengthof Open Trench

Thestretch of worktobetackled shallbelimitedtotwo adjacent manholes. However, the Engineer may permit only reasonable trench excavation in advance of the lengths between two adjacent manholestoensurelayingandjointingofpipescanreasonablybeexpectedtobecompletedandthe trench refilled not attended later than 3 days after excavation of the trench. The Contractor will not bepermittedtokeeptrenchesopenforundulylongperiods,creatingpublichazards. TheEngineer's decision in this respect shall be final.

TrenchSides

Loose boulders shall be removed from the sides of the trenches before allowing workmen into the excavation,andthetrenchsidesshallbestabilizedwithscreeningor othermethodsapprovedbythe Engineer. Trench slopes shall be kept moist where necessary to prevent local sliding as ordered by the Engineer.

WideningTrenchatJoints,etc.

Any widening or deepening of the trench, whether in ordinary soil or rock, necessary to accommodatecurves,jointsorbendsasshownonthedrawingsororderedbytheEngineershallbe carried out by the contractor.

Over-excavationoftrench bottoms

Allexcavationcarriedbelowthegradesshownondrawings,shallberefilledwithcompacted bedding material at the Contractor's expense.

Excavatedmaterial

Thematerialfromtheexcavationshall bedepositedoneithersideofthetrenchleavingclearbermon one side at least 40 cm wide or at such further distance from the edges of the trench as may be necessary to prevent the weight of materials from causing the side of the trench to slip or fall, or at such a distance and such a manner as to avoid covering fire-hydrants, sluice valves, manhole covers and the like and so as to avoid any wall or structure or causing inconvenience to the public or other persons or otherwise as the engineer may direct, till it is carted away.

Theexcavatedsoilshouldbesoplacedandhandledasnottoinconveniencetheusualtraffic,tillitis cartedaway.Thecontractorshouldalsoprovidenecessarybridgingovertheexcavatedtrenchesfor the house-holders and pedestrians tocross overand vehicular crossings ifand whererequired at no extra cost, if the Engineer decides that there is no hindrance to traffic due to not carting away the excavated earth, he will give instructions to that effect..

Themanholeframesandcoversfromtheexistingmanholesshallbecarefullyremovedandstoredin a suitable place away from the trenches. The contractor should not break the manhole frames and covers while removing. The contractor is responsible for the safety of manhole frames and covers.

PipeBedding

iii) GranularBedding

The bed of trenches shall be prepared as per drawing. Sand used for back fill shall be naturalsand(freefromcinders,ashes,slag,refuse,organicmaterials,boulders,rocksor stones) graded from fine to coarse or manufactures sand as per BOQ & contract specifications. The total weight of clay in it shall not exceed 10%. All materials shall pass through a sieve of aperture size 6.30 mm.

iv) Gravel/MurramBedding

The bed of the trenches shall be prepared as per drawings. The approved granular material shall be of size less than 25mm (murrum) and work shall include watering and consolidationbypunnersetc.,completewithallleadandlifts,asperspecificationandas directed by the Engineer complete

v) StonedustorquarrydustBedding

Thebedofthetrenchesshallbepreparedasperdrawings**.**BeddingorBackfillingshallbe

usingapprovedstonedust/quarrydustofsizenotexceeding5.6mmforthepipeline
trenchesandworkshallincludewateringandconsolidationto95%proctordensityetc.,
completewithallleadandliftsasperspecificationandasdirectedbytheEngineer complete

vi) ConcreteBedding

Thistypeofbeddingisasperthedrawingappendedwiththetenderdocument,andisto be provided at locations shown in drawings or as specified by the Engineer. A concrete bedding as per BOQ provisions shall be provided mostly in weak strata and in storm water drains. The concrete work related to this specification is detailed in the specifications of concrete and allied works.

In case of sewers laying in storm water channels, the pipe shall be encased with cement concrete/reinforcedcementconcrete of grade as per BOQprovision witha minimumthickness of150 mmallaroundorasperbeddingdrawing. Iftheclear distancebetweendrainbedandpipetopismore than one meter then concrete bedding as directed by the Engineer shall be done.

Trenchexcavationin hardrock

IfanymaterialwhichintheopinionoftheContractorcanbeclassifiedashardrockisencountered, he shall immediately inform the Engineer and the level, extent and description of the material encountered shall be measured jointly and recorded before excavation.

OnlysuchproportionofmaterialnotifiedandmeasuredwhichiscertifiedbytheEngineeras"rock", shall be paid for as rock excavation.

Excavationfortrenchesinrockshall besocarriedoutsuchthattheclearancebetweenthepipe,when laid in position and the sides and trench bottom shall be kept to the minimum limits necessary to provide for specified thickness of bedding, and surround to the pipe as specified. Excavation outside the specified limits shall not be paidfor and any additional expenses incurred in providingadditional strength to the pipe to overcome the increased trench loads on account of increased width shall be at the Contractor's expenses. The rock thus excavated shall be auctioned as directed by Employer/Engineer as per GOK procedures and the auctioned amount shall be remitted to the Employer/Engineer.

Excavation forappurtenances

Excavation in trenches for foundation anchor blocks, pedestals etc. shall be as per the plan or as directedbytheEngineer.Thedimensionsoftheexcavationshallbemeasuredasthe projectionin plan of the outermost edges of the structure.

Pumpingsewageordiversion bygravityand dewatering

General

TheworksincludedinthisSectionareasfollows:

4) Provision of all labour, equipment, materials etc. to ensure a safe and dewatered condition in all areas in which the work in this contract are to be executed.
5) Continuousoperationofthedewateringsystemsisrequiredtocompleteall portionsofthe workswheredewateringandpumpingofsewageisnecessarytopreventinfl ow,collection of surface water or ground water, or sewage or to protect adjacent properties or constructionsfromdamageresultingfromariseorfallofgroundwaterlevel sorsewage.
6) Removaloftheequipmentwhennolongerrequired.

Pumpingoutwateranddewatering

TheContractorshallprovideandworkat hisowncost,allpumps,enginesandmachineryrequisiteto keep thetrenches for the sewers or foundations and allother excavations clear ofwater, whethersub- soil water, storm water, sewage, leakage from tanks, wells, drains, sewers, water mains or pipes etc., sothattheremaybenoaccumulationsofsuchwaterandthatnosettingoutmaybedone, nomasonry may be laid, no concrete deposited, no joints made and no measurements taken in water.

The pumping shall be continued so long after execution of any portion of the work and repeated so after as the Engineer may consider necessary. The pumps and power applied must be such as the Engineermayconsidernecessaryfortheworktoset.Thepumpsandpowerappliedmu stbesuchas the Engineer may determine to be sufficient to any particular time so that he may stop the work altogether until he is satisfied and also impose a fine upon the contractor

TheContractorshallberesponsiblefortheadequatepumping,drainageandbailingou tofwaterfrom the excavation with all rates of recuperations. Dewatering shall be either continuous or intermittent using method approved by the Engineer. The method of dewatering shall depend on site condition shouldbefurnishedbytheContractorandapprovedbytheEngineer.Themethodofde wateringshall be either sump pumping or well point dewatering. The effectiveness of each method will depend upon the nature of the soil, the proportions of the trench and degree of lowering required. Pumping test may be necessary to determine which method is suitable. If sump pumping is not practicable other control methods shall be considered and should be approved by the Engineer. The trenches should be kept dry till the completion of work, which includes excavation, pipeline laying, jointing, testing and commissioning and backfilling. Precaution should be taken against the flotation of the pipes. The Contractor shall conduct ground studies if found necessary and the cost for such studies have to borne by the Contractor himself.

TheContractorshallberesponsiblefortheadequatepumping,drainageandbailingo utofwatermet due to all causes from the excavation for laying sewer pipe lines and all types of constructions. In case of failure to make such provisions or any

other provisions, which may result in unsuitable sub- grade conditions, the Contractor shall replaceand repairthe sub-grade asdirectedto the satisfaction of the Engineer, at his own cost and responsibility.

ShouldtheContractorselecttouseagravelsub-gradewithorwithoutunjointedpipeswiththegravel layers to facilitate flow of water to pumps or other points of disposal, such gravel sub grade with or without conveyingpipes shall not be measured or paidas an extra itemand rate for the same shall be deemed to be included in the other pay items of BOQ.

Sump pumping

This method may be used in highlyand moderatelypermeable soils such as gravels, sand and gravel mixtures.Thismethodissimpleandcheaptoinstallandusedwithwatertighttrenchsheetingtolimit the volume of flow. To prevent the boiling in the bottom of the trench the following precaution should be taken.

Drivesheetingdeepertolengthendraina

gepath; Use open pipe surrounded in

gravel as a sump; Move the sump to

one side of the trench;

Topreventremovaloffinesfromsoilcausinglossofstrengthinthesoilandunderminingofthe trench bottom and side support, surround suction inlet with protected graded filter;

Increaseflowratethroughthesoilbyusingopenpipesurroundedwith gravel.

The delivery side of the pump should be monitored by taking samples of water and checking the proportionoffinesbeingremoved. Iffinesare beingcontinuouslywithdrawnnortherearesignsof trench instability, sump pumping should be stopped and alternative methods to the considered.

Well pointing

In this method well points are installed at regular intervals on one or both sides of the trench and linked parallelto aheadermain connectedto apump. Well points are usuallyinstalled at 0.6to 2.0m centre to centre by jetting them in. In ground with dense layers or cobbles & boulders it may be necessary to pre bore the layers. The efficiency of the well points is increased bysanding in the well point and riser using a column of sharp sand. This method has an advantage of drawing water away from the trench and in suitable conditions is effective in lowering the water by 4 to 6m below excavation level. It will also reduce the hydrostatic heads on the trench support system. Its greatest useinsand,theheavyflowsimpermeableground,suchasgravels,meansthatthewellpointshaveto besoclosetogetherthatthemethodbecomesimpractical.Inclaystherateofseepageistoosmallfor the system to be properly effective. Silts can be stabilized in certain conditions by using special procedures.

Thewellpointingshallbeeithersinglesidedwellpointordoublesidedwellpoint.Forhigherdepths double sided well point with multi stage shall be considered. Should the Contractor select to use a gravel sub-grade to facilitate flow of water to pumps or other points of disposal, such gravel sub- grade shall not be measured or paid for as an extra item. Contractor should assess the availability of extra earth required for refilling in case of shortage in any particular reach

well before quoting rates. Even in case the Contractor resorts to mechanical excavation, the Contractor should take care of proper refilling, consolidation and disposal of surplus earth.

Disposal of ground water is to be away from the area of influence of the pipe laying area Suitable temporarypipelinesaretobelaidtoexistingwatercourses.Forloweringthesubsoilwaterlevel for the construction of wet wells the bores have to be installed/jetted at distance between two bores

varyingfrom0.6to1.0mdependinguponsubstrataandtheincomingflowofwater.The boreshould be installed at least 1.0m away from the periphery of the excavated earth. The dewatering includes removal of ground water, springs, seepage water, sullage, sewage, running water, rain water etc., in order to make the trench for pipe line works etc. It is to be noted that contractor can adopt thesuitable type of dewatering the keep the trench dry until completion of all sewer laying and testing works.

Keepexcavation clearofwater

Wheregroundwater/ Nallahsurfaceflowisencounteredoranticipatedthecontractorshallprovide sufficient pumps to handle the ingress of water and must provide and maintain in working order. Standbypumpingunits are to be made available and employed in the event of mechanical failure. The contractor must also arrange for night and day operation of the pumps wherever necessary to ensure that the work proceeds at all times.

Barricading,watching,lighting

The parts of the barricadingshall be of timber,securelyfixedinthe ground not more than 2.50 m apart.Theyshallnotbelessthan10cmindiameterandnotlessthan1.5mabovethesurfaceofthe ground.There shall betworails,one near thetopof the posts andthe otherabout 0.50mabovethe groundandeachshallbeof5cmto10cmindiameterandsufficientlylongtorunfrompost topost towhichtheyshallbetiedwithstrongropesortheworkshallbecarriedoutasperBOQ provisions.

The method of projectingrails beyond the posts and tyingtogether wherethey meet will not be allowed on any account. All along the edges of the excavated trenches, a bund of earth about 1 m highshallbeformedwhensodirectedbytheEngineerforfurtherprotection.Proper provisionshall be made for lightingat night and watchmenshall be kept to see that this is properly done and maintained.Inadditiontothenormallightingarrangementsthecontractorshallprovide,whenever such workis in progress, battery operated blinkinglights (6 volts) in the beginningand end of a trench with a view to providesuitable indicationtothe vehicular traffic.Thecontractor shall also provide and displayspecial boards printed with fluorescent printsindicatingthe progress of work along-theroad.Further,inallsuchcasestheworkmaybecarriedoutdepartmentallyatthe riskand costofthecontractor.Thecontractorshallbeheldresponsibleforallclaimsforcomp

ensationasa result of accident or injury to person and non-provision of red flags.

TheContractorshallathisowncostprovideallnoticeboardsbeforeopeningofroads asdirected by the Engineer.

Arrangementsshallbemadebythecontractorstodirecttrafficwhenworkisinprogre ss.No separate payment shall be paid for this item of work.

Refillingtrenches

10) With a view to restrict the length of open trenches, on completion of the pipe, laying operations, refilling of trenches shall be started immediately by the contractor. Pipe laying and testing shall follow closely upon the progress of trench excavation and the contractor shall not be permitted unreasonable excessive lengths of trench excavation to remain open while awaiting testing of the pipe line.

11) Thetrench shall be filled byborrowed gravelor approved material up to at least30 cm. above the top of pipe, back filling is to be done keeping at least 90 cm. length of pipe open at the joints, for verification of joints for water tightness during testing.

12) Care shall be taken while back filling, not to injure or disturb the pipe. Filling shall be carried out simultaneously on both the sides of the pipes so that unequal pressure does not occur.

13) Walking or working on the completed pipeline shall not be permitted unless the trench has been filled to a height of at least 30 cm over the top of the pipe except as may be necessary for tamping, etc., during back filling work.

14) Filling-in shall be done in layers not exceeding 150 mm in thickness accompanied by adequatewatering,ramming,etc.,soastogetgoodcompactionupto300m mabovethe top of the pipe. Above this level, useful excavated earth free from boulders shall be placed in layers of 150 mm, watered and compacted by tamping. Wherever pipe is laid in the storm water channel, total refilling shall be done with borrowed earth or as directed.

15) The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place.

16) Before and during the backfilling of the trench, precautions shall be taken against the floatation of the pipeline due to the entry of large quantities of water into the trench causing an uplift of the empty or the partly filled pipeline.

17) In case of sewers laid in storm water channels, after refilling is

done, the bed of the channel to the extent trench width shall be made with cement concrete of grade M15 with a thickness of 150mm as per the site requirement and as directed.

18) Optimum Moisture Content (OMC) test to be carried at trench section and Maximum Dry Density (MDD) test for the refilled soil in trench to confirm the proper compaction up to 95% of maximum dry density.

Refillingtheroadsurface

Afterthebackfillingiscompleted,thecontractorshallrestorethesurfaceofthetrenchoverthepipe to that road surface existing prior to excavation, i.e., either bitumen or cement concrete as the case may be and verified from the adjacent surface. This will be paid as per the Bill of Quantities. The width for the payment of road cutting or restructuring will be only as per the direction of the Engineer. The work of restructuring of road surface either by bitumen or cement concrete shall be as described in chapter Road restoration.

Subsidenceinfilling

Should any subsidence take place in the filling at any place of work i.e. at manholes and over pipe trenches and road surface whatsoever during contract, the contractor shall make good the same at hisowncost ortheengineermaywith orwithoutnoticetothecontactormakegoodthesameinany way and with any material that he may think proper, and at the expense of the contractor. The engineermayalso,ifheanticipatestheoccurrenceofanysubsidence,takenecessary actiondeemed fit in which case also the expenses therefore shall be charged to the contractor.

Disposalof excavatedmaterials

Excavated materials shall be used for refilling etc. and surplus earth shall be disposed off to the outskirts of corporation safely with all leads and lift as directed by the engineer. In case of pipe layingworktobecarriedattheouterperipheryofthelakes,theexcess material shallbeusedfor filling and embankment formation along the outer periphery of the lakes for laying of the sewer network

Allworks tobe clear,clean and perfect

TheContractor,aftercompletionofentireworkandbeforeseekingsettlement ofhisfinalbill,shall proveat hisexpensethat theentirelineisclear,cleanandperfectinthepresenceoftheEngineeror his authorized subordinate. He should provide suitable instruments, appliances etc., and pass them through the pipes and shall show that water passes freely

through the entire reach from higher end to lower end. Necessary precautions such as those indicated hereunder may be taken by the Contractor while checking the completed sewer line for its effective functioning, whereverrequired.

The manholes should be kept open, as required for one hour or as required, prior to the startingof checkingoperationsandshouldbesokeptopenduringthewholedurationofcheckingoperations. This is to be done for allowing the gases to escape, naturally. In order to prevent fire and explosions, .endangering the life, properties, sewers and other utility services due to presence of combustible gases, no lighted match sticks or other similar material should be thrown in the manhole. All necessary safety equipment's, gadgets and sensors shall be used in the restricted working areas.

Meshes should be placed over the opened manholes to prevent pedestrians etc., from falling in. Likewise,cautionboardsprintedinfluorescentletterssuchas"DANGERMANHOLEISKEPT OPEN" etc., shall be provided.

Layingofsewerpipesalongthewaterbody

It is to be noted that sub-mains/trunk lines needs to be laid along the edge of tank/water bodies. If permitted,theedgeofthetankshallbefirstfilledwithearthandlaterpipelayingworkcanbetaken up and the excess soil shall be used for this purpose.

Measurement

Themeasurement ofexcavationshallbemadeonquantitybasisaspertheactualdimensionsofthe trench excavated limited to the width shown in the drawings or as directed.

e) Trenchexcavation

Thelengthofthetrenchexcavationshallbemeasuredalongthecentrelineofpipeatvarious depths stated in the Bill of Quantities, the total length being segregated into stretches according to the various depths of excavation contained in the Bill of Quantities to fall into the specified categories. Within each stretch the depth applicable shall be within the range specified in Bill of Quantities.

The depth of excavation shall be measured from the top of the trench at the centre before excavation upto the bottom of the bedding under the pipe. If no bedding is provided, the measurementshallbetothelevelofthebottomofthepipeline.Thewidthofthetrenchshall be measured on the basis of vertical side walls and the specified widths. No additional payment shall be made for the widening at sockets, specials, hunching or surrounds beyond the dimensions

specified.

f) Structures

Measurementforstructureexcavationshallbemadeasperttheprojectioninplanofthe outermost edges of the, structure as per the plan at the bottom.

g) Rockexcavation

Thedepthofrockexcavationmeasuredforpaymentshallnotexceedthecorresponding depth in ordinary excavation or as directed by the Engineer.

In all above cases, no payment will be made for additional selected fill, lean concrete, beddingcradlingorhunchingconcretethatmaybespecifiedororderedbytheEngineerasa consequence ofexcavatingbeyond thelimitsspecifiedin the contract documents or ordered by the Engineer.

The contractor has to auction/dispose/use himself the excavated hard rock as per GOK guidelinesandtherevenuegeneratedinthismannerwillberecoveredinhispayment atthe prevailing rate of Royalty with applicable GST.

h) Disposalofexcavatedmaterial

Alltheexcavatedmaterialshallbecartedawaywithallleadandliftanditincludes loading, unloading, transporting with all lead and lift and as per Engineers directions.

SECTION2

CONCRETEAND ALLIEDWORKS

3 General

Thequalityof materials and method and controlof manufacture and transportation of allconcrete workirrespectiveofmix,whetherreinforcedorotherwiseshallconformtotheappli cableportions of this specification.

The Engineer shall have the right to inspect the source/s of material/s, the layout and operation of procurementandstorageofmaterials,theconcretebatchingandmixingequipment, andthequality control system. Such an inspection shall be arranged and Engineer’s approval obtained, prior to starting of concrete work. However, this shall not relieve the contractor with any of his responsibilities and all the materials, which do not conform to the specifications, will be rejected. The detailed specifications are provided in Part 10-A, Standard Technical Specifications

SECTION-3

SEWER APPURTENANCES

Manholes

The manhole shall be provided with RCC manhole depending upon diameter of sewers and dependinguponthealignmentofproposedsewerwhetheritisonroadorinStormWaterDrain (SWD)/in STP/ISPS premises.

ThePrecast/CastIn-situRCCaredefinedwiththefollowingconditions.

- RCCPrecastmanholes–foralldepths
- RCCCastinsitumanholes–Instormwaterdrains,foralldia.ofpipeandforalldepths.

ItisintendedtoConstructRCCprecast/Castinsitumanholesfortheproposedseweragesystem

(iv) Location

Manholesshallbeconstructedatplacesasshownonrelevantdrawingsandas directed by the Engineer.

(v) Excavation

Excavation,shoring,dewateringetc.forthepitsofmanholesshallbedonein accordance with specification.

(vi) General

In general,plainandreinforcedconcretework formanholesshallbecarriedoutinaccordancewith the specification and drawing. The RCC Precast/Cast in Situ manholes shall be of minimum RCC M30 grade concrete using sulphate resistant cement.

Construction of RCC manhole chambers of in M30 grade proportion orapproved type pre-castRCCmanholechambers,constructedusingformvibratorsofstandardtype,with barricading,danger lightingand usingof sight rails andboningrods whenever necessary, shoringandstruttingwherever required using sulphate resistant cement, withminimum M30 grade RCC with 20 mm and downgraded jelly, well graded sand and steel of approved quality, minimum 200 mm thick top concrete slab or as per approved drawings, having wall thickness and raft thickness as in approved drawings and with an offset in raft all-round the chamber as in approved drawings, benching concrete with 1:6 slope towards the central drain finished smooth, including fixing and grouting of pipes, including conveying to work spot supply and fixing of SFRC manhole cover and frame (Heavy duty) confirming to IS 12592 with latest amendments, on a bed of CC 1:2:4 supplying and fixingof minimum3 mmthickencapsulated plastic footsteps(as per IS 10910) on 12 mmdia Grade FE-415 steel bar (as per IS 1786) staggered at 300 mm apart as detailed in technical specifications,

including sand & boulder bedding wherever required, disposal of surplus earth, dewatering until completionofworks,curing,engravingmanholenumberwithflowdirectiononthein nercylindrical surface etc complete including cost of reinforcement steel and fabrication charges, shuttering,

shoring, keeping the trench dry until completion of works, including cost of transportation and erectionofprecastmembersfromyardtositeandalsocostand conveyanceofallmaterials,labour complete with all lead and lift. The precast RCC manhole/Cast in situ chambers are for various diameters and depths as per detailed drawings, specifications and direction of the Engineer

The RCC Precast manholes shall be of minimum RCC M30 grade concrete. The manhole shall be constructed using sulphate resistant cement. The rubber seal joints shall be provided in between precast units, rubber gaskets shall be as per IS 5382. The joints shall be sealed with non-shrink grout. Singlerubberseal shallbe providedin betweenprecastunits. Allreinforcement bars shall be HYSD CRS bars of grade FE 500 confirming to IS 1786. The non-core opening shall be 100 mm greater than the outer diameter ofthepipe.Theliftingholesshall befilled with Concrete. It maybe noted that single offset joint configuration shall be adopted at the joint. Based the site requirement, direction of the Engineer or at the request of the contractor, contractor can construct cast in-situ manholes in place of precast manholes with contractors approved design and drawings in restricted areas.Provisionforhouseserviceconnectionpipesifrequiredshallbeprovidedaspe rthedirection of the Engineer.

Themanholesshallbeconstructedatplacesshownon thedrawingsorwhereverdirectedbythe Engineer.

(vii) Cementconcretechannel

ThechannelforthemanholeshallbeconstructedincementconcreteofM 15grade.
Bothsidesofthechannelshallbetakenuptothelevelofthecrownoftheout going sewer. They shall be benched up in concrete extended vertically 50mm above and renderedincement mortar(1:2)of20mmthicknessandformedtoaslopeof1in6 towards the channel.

The branch channels also be similarly constructed with respect to the benching
butattheirjunctionswithmainchannel,anappropriatefall,ifrequireds uitablyrounded off, in the direction of flow in main channel shall be given.

(vi) Pipeenteringorleavingmanhole

Wheneverapipeentersorleavesamanhole,thepipeshallbeencasedwit h the concrete all around the pipes covering the joints.

(xi) Rungs/footsteps

Rungs/ footstepsshallbeprovidedinall manholesandshall beManufactureand
conformstothedimensionsofIS5455:1969arereinforcementencap

sulatedwith PVC. The surface finish shall have 2mm tread on top by ribbing or chequering.
Theserungsmaybe300mmapartverticallyandshallprojectaminimumof100 mm beyond the finished surface of the manhole wall.
The top rung shall be 450 mm below the manhole cover and the lowest not more than 300 mm above the benching. Rungs shall be tested as per IS and approved before usage.

(xii) Frameandcovers

Frameandcoversformanholesshallbeofrequiredtypeanddimensionsasperthe relevant drawings.

Followinginformationshallbeclearlymarkedoneachcover.

f. Yearof manufacture
g. Identificationmarkofthepurchaser
h. SEWER/SWD
i. Arrowshowingdirectionof flow
j. Nameofmanufacturer/Trademark

(xv) SteelFibreReinforcedConcrete(SFRC)FrameandCover

SteelFibreReinforcedConcrete(SFRC)frame andcovershallbeasmanufactured asperIS12592. (Latestedition).Thecontractortosubmitthestructuraldesignand drawing of frame and cover and get it approved before manufacturing the same.

(xvi) DropManhole

When a sewer connects a main sewer, and where the difference in level between waterline(peakflowlevels)ofmainlineandtheinvertlevelofbranchlineismore than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a manhole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer.

(xvii) Measurement-Manholes

Thedepthofmanholeshallbemeasurefromthetopofcovertotheinvertlevelof the deepest outgoing sewer from the manhole. The measurement shall be per number basis and as per the actual depth of manhole constructed.

Notes:

If any damage is caused to the other services such as water supply pipeline, sewer, cable/ other utilitiesetc.duringtheconstructionofmanholesContractorshallbeheldresponsible forthesame and shall replace the damaged services at his own cost to the full satisfaction of the Engineer.

Theinteriorofmanholesshallbeclearedofall debrisafterconstructionandbeforetestingthesame for water tightness by Contractor at his own cost.

Waterfortestingofmanholesalongwithpipelineshallbearrangedby Contractorathisowncost.

Existingconnections

All existing connections which are removed during the uprooting of the existing sewer if any shall be replacedand reconnected withnew sewer as per thedirections ofthe Engineer.Thereplaced new sewerconnectionsshallbeproperlylaid,jointedandconnectedasperthedirectionso ftheEngineer. During the execution work of replacing sewer if the bedding of the connection has been disturbed it shall be replaced with new bedding as per specification contained in the tender document. After making the connection to the sewer, back filling shall be done in layers as directed by the Engineer.

Ventilationshafts

VentilationshaftsaretobeprovidedforthemanholesinSWDoratplacesasdirectedb theEngineer. Theconnectingpipefrommanholetoventilatingshaftshallbe DIK-9150 mmdiameter.A foundationblockof150mmthickPCCinM15isprovidedsurroundingthepipe.Theve rticalshaft shouldbemadeofductileironanditshouldbearound6mhighabovethegroundlevela ndthe internaldiameteroftheshaftshouldbe150mm.Allthedimensionsaretobetakenasp ertender drawing.Thejointofpipesformingtheventilatingshaftshouldbemadeairtight.Thel ocationofthe ventilatingshaftshouldbesuchthatitshouldnotcauseanynuisancetothevehiculart rafficandthe movementofpedestrians.Theplacingofventilatingshaftshouldbeasperthedirectio nsofEngineer incharge.Thedetailsoffixingtheventilatingshaftsareprovidedinthedrawinggiveni nthetender document.

Concretecradles,haunching, etc.

Theconcretecradlesshallbeconstructedinsitubythecontractor,indicatedinthedra wings,in places wherever required as decided by the Engineer.

PrecastConcreteBlocks(Anchorblocks)

It is proposedtolaypartofthe DWCpipes besides/inside stormwaterdrainsorinwaterlogged areas. It is intended that the contractor shall dewater/divert and keep the trench dry before laying of the pipes. The contractor shall provide the anchor blocks or uplift arrangements as per the drawings andas directed. The contractor shall provide precast anchor blocks or uplift arrangements as per the BOQ provisions and as per drawings.

SECTION-4

SPECIFICATIONFORSFRCMANHOLECOVERS

Scope

Contractor'sscopeincludesthedesign,manufacture,supplyingandfixingtheFRCmanholeframeand covers.Thewetconcrete mixissubjectedtopressureappliedthroughahydraulicjackthrougha plunger keptatthetopofthewetmix.TheFRCmanholecoversshallbeabletoresist20tonnesloadbearing capacity.ThedimensionsshallbeasperIS:12592.A25x3mmthickMSFlatallaround theframeis weldedtothemainreinforcementoftheframesoastogetaclearopeningof560mmdiameter.A18 SWGMSstrapallaroundthecoverandliftingarrangementof12mmdiameterMSbar sweldedtothe mainreinforcementarealso tobeprovidedfor liftingthe manholecovers. Acoatofepoxypaintshallbe appliedtotheundersideandsidesoftheframeandcover.

General

c) Thequalityofmaterials,methodoftestingshallbeapprovedbytheEngineer.

d) The Engineer shall have the right to inspect the source/s of material/s, the layout and procurement, the equipment, quality control system, testing of material etc. If the Engineer desires the sample of the FRC cover or materials used for the manufacture of FRCcovers,testcertificatefromapprovedlaboratory.Thenthecontractorshallarrange the same without any extra cost.

Material

f) Cement

Unlessotherwisespecifiedinthespecificationorcalledfortheengineer,cementshall be ordinary Portland cement as per the relevant IS code. More details are mentioned on the section of concrete under this tender document.

g) Fineaggregates

Thedetailsofthishavebeenmentionedinthesectionconcreteandalliedworksofthis tender document.

h) Coarseaggregate

Coarseaggregateforconcrete,shallconformtoIS:383.Thisshallconsistofcrushed stoneandshall be cleanand free fromelongatedflaky or

laminatedpieces,adhering coating,claylumps,coalresidue,clinkers,slag,alkali,mica,organicmatter orother deleterious matter, the maximum size of the aggregate shall be 12 mm.

i) Water

Waterforuseinconcreteandcuringshallconformto IS:456/1964anditssubsequent amendments.

Water/cementratio

Thewater-cementratioshall *be0.40to0.45to*yieldagoodworkability.Theworkabilitycan be increased by using appropriate admixtures.

Fiber Reinforcement

Thefibersarecutfrom0.40mmdiahightensilesteelwiresofabout 12000kg/cm2ultimatestress. The fiber content for the manufacture of FRC covers is of the order 1 to 1.25% by volume of the concrete.

DesignMix

Thevendorshalldesignthemixdesignoftheconcretewhichisexpectedtogiveaconcrete compressive strength as per IS:12592

Mixing

Concreteshall bemixedinamechanical mixer.Mixingshall becontinueduntilthereisauniform distribution of the materials and the mass is uniform in colour and consistency.

PlacingandCompaction

Thereinforcementshallbeplacedinproperpositioninsteelmouldscoatedwithathinlayerofmould oil. Concrete shall be filled to slightly overfill the moulds and compacted by vibration and struck off level with a trowel.

Use of needle vibrators for compacting the wet concrete mix containing fibres is not recommendedsince the holes left by the vibrator in the wet mix may not close after its removal owing tointerlockingofthefibreswiththemix.Compactionbymeansofshutterorformortablevibrators isrecommended.Incaseofextraheavydutyandheavydutycoverframes,compactionbymeans of pressure cum-vibration technique may also be employed so as to achieve dense and strongconcrete. Clear cover to reinforcement shall be not less than 15 mm. After de-moulding,

coverframesshallbeprotecteduntiltheyaresufficientlyhardenedtopermithandling withoutdamage.

Curing

The hardened concrete manhole cover frame shall be placed in a curing water tank or taken to the curing yard where they shall be kept continuously moist for at least 28 days. Frames may be water cured by immersion in water, covering with water saturated material or by a system of perforated pipes. Mechanical sprinklers or any other approved method that will keep covering frames moist during the specified curing period. Steam curing of manhole cover frames may be adopted insteadof method specified above provided the requirements of pressure or non pressure steam curing are fulfilled and the manhole cover frames meet the requirements specified in this section.

EdgeProtectionandFinishing

Thetopandinsidesurfaceofcoverframesshallbesmooth.Topreventthe topouteredgefrom possible damages, it shall be protected by 25 mm x 3 mm mild steel flat as part of the frame.
Sufficientnumber ofsteelconnectorsshall beweldedtotheinnersurfaceofthemildsteelflatsoasto connect it with the frame reinforcement and these shall be embedded in the concrete during casting.
Exposedsurfaceofmildsteelflatshallbegivensuitabletreatmentwithanticorrosivepa intorcoating. Suitable arrangements may be made for fixing the manhole cover frames in position on the manholes by mutual agreement between the manufacturer and the purchaser.

Physicalrequirements

General

All the frames shall besound andfree fromcracks and other defects whichinterferes with the proper placing of the units or impair the strength or performance of the units. Minor chippings resulting fromthecustomarymethodsofhandlingandtransportationshallnotbedeemedgrou ndforrejection.

1. Dimension

The inside dimensions at top shallmatch with the corresponding covers so that the maximumclearanceattopbetweentheframeandthecover is notmore than5mm andthetopsurfaceof theframeandcoverisinlevelwithinatoleranceof. ±5mm.

2. ScaleofSampling- LOT

In a consignment 500 precast concrete manhole cover frames or a part thereof, of the same typeand dimensions and belonging to the same batch of manufacturer, shall be grouped together toconstitute a lot For ascertaining

conformity to the materials in the lot to requirements of thisspecification, samples shall be tested from each lot separately. The number of cover frames to beselectedfromthelotshalldependonthesizeoflotandshallbeaccordingtothefollowingtable:

Scaleofsamplingandpermissiblenumberofdefectives

No.ofcoverFramesintheLotDimensionalRequirement

	SampleSize	**AcceptanceNumber**
Upto100	10	1
101to200	15	1
201to300	20	2
301to500	30	3

SECTION–5

RCCSOCKETSPIGOTNON-PRESSUREPIPES

General

RCC NP3 and RCC NP4 class pipes shall be used as per the requirement. These pipes shall be in accordancewiththespecificationsmentionedinIS:458-2003anditsAmendments.Theseproposed pipesshallbeinaccordancewiththespecificationsmentionedinrelevantISandforwhichnoextra cost other than the one which is mentioned in BOQ will be paid.

Materials

Forpre-castreinforcedconcretepipes,materialscomplyingwiththerequirementsgivenin(i) to (v) shall be used.

a) Cement

CementusedRCCNP3pipeshouldbemanufacturedwithSulphateresistantcementand conforms to IS: 12330-1988

b) Aggregates

Aggregates used for the manufacture of reinforced concrete pipes shall conform to IS:383-1970.Themaximumsizeofaggregateshouldnotexceedonethirdthethicknessofthepipe or 20 mm, whichever is smaller.

c) Reinforcement

Reinforcement usedfor the manufacture of the reinforced concrete pipes shall be mild steel GradeIormediumtensilesteelbarsconformingtoIS: 432(Part1):1982orharddrawnsteel wire conformingto IS: 432 (Part 2) or structural steel (standard quality) bars conformingto IC: 2062.

d) ConcreteorMortar

The quality and design mix requirements of concrete (concrete mix, maximum water-cement ratio, minimum cement content, etc) used for the manufacture of reinforced cement concrete pipes and collars shall conform to IS:456-2000 for at least very severeenvironment exposure condition and shall also be in accordance with Concrete andAllied works Section of Technical Specifications. In case of pipes cast by spinning process, higher cement contents, more fines and higher water-cement ratio may be theneed of the process.

The concrete for non-pressure pipes shall have a minimum compressive strength of 35 N/mm2at28days.If mortarisused,itshallhaveaminimumcementcontentof450kg/m^3 and a compressive strength not less than 35 N/mm2 at 28 days.

Compressivestrengthtestsshallbeconductedon15cmcubesinaccordancewiththe relevant requirements of IS:456-2000 and IS:516-1959.

The manufacturer shall give a certificate indicating the quantity of cement in the concrete mix.

vi) RubberRing

RubberringchordsusedinpipeJointsshallconformtoType2ofIS:5382-1985.Rubbers rings shall be tested and approved before usage.

Design

i. General

Reinforced concrete pipes either spun or vibrated cast shall be designed such that the maximum tensilestressinthecircumferentialsteelduetospecifiedhydrostatictestpressuredoesnotexceedthe limit of 125 N/mm^2 in the case of mild steel rods, 140 N/mm^2 in the case of hard-drawn steel wires and high strength deformed steel bars and wires.

The barrel thickness shall be such that under the specified hydrostatic test pressure, the maximum tensile stress in concrete, when considered as effective to take stress along with the tensile reinforcementshallnotexceed 1.5N/mm^{2}fornon-pressurepipes.Thebarrelwallthicknessshallbe as per IS:458-2003.

Longitudinalreinforcementshallbeprovidedtoensurerigidityandcorrectlocationof cages(grids) longitudinally and to limit the effects of transverse cracking. Minimum longitudinal reinforcement shall be as given in respective tables of IS:458.

ii. Reinforcement

Thereinforcementinthereinforcedconcretepipeshallextendthroughoutthelength ofthe pipeandshallbesodesignedthatitmaybereadilyplacedandmaintainedtodesignedshape andintheproperpositionwithinthepipemouldduringthemanufacturingprocess.The circumferentialandlongitudinalreinforcementshallbeadequatetosatisfytherequirements specified under (i).

Thepitchofcircumferentialreinforcementshallbenotmorethanthefollowing:

d) 200mmforpipesofnominalinternaldiameter80to150mm,
e) 150mmforpipesofnominalinternaldiameter200to350mm,and
f) 100mmforpipesofnominalinternaldiameter400mmandabove.

Thepitchshallalsobenotlessthanthemaximumsize ofaggregateplusthediameterofthe reinforcement bar used.

The quantity and disposition of steel in pipes may be decided by mutual agreement between the BWSSBandthesupplier;however,itshallbeprovedbycalculationsandteststhatthequalityofthe pipes conforms to all the requirements specified in the standard. In the absence of calculations and tests, the reinforcement given in the respective tables of IS:458 shall be used as minimum reinforcement.

If so required by the BWSSB, the manufacturer shall give a certificate indicatingthe details relating toquality,quantityanddispersionofsteelinthepipesaswellastheclearcovertotheste elprovided in the pipe.

iii. EndsofPipes

Dimensions of spigot and socket for rubber ring roll on jointed pipes shall be as given in the respectivetablesofIS:458.Reinforcementinsocketofrubberringjointedpipesshallbeasgivenin the respective tables of IS:458-2003.

Manufacture

General

The methods of manufacture shall be such that the form and dimensions of the finished pipe areaccuratewithinthelimitsspecifiedinthisstandard.Thesurfacesandedgesofthepipesshallbewell defined and true, and their ends shall be square with the longitudinal axis.

v) Concretemixing

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniformdistributionofthematerialsandthemassisuniformincolouradconsistency,butin no case shall the mixing be done for less than two minutes. Water-cement ratio shall be less than 0.5.

The concrete shall be placed before setting has commenced. It should be ensured that the concreteisnotdroppedfreelysoastocausesegregation.Theconcreteshallbeconsolidated byspinning.Vibrating, spinningcombined with vibrations,or other appropriate mechanical means.

vi) ReinforcementCages

Reinforcement cages for pipes shall extend throughout the length of pipe barrel. The cages shall consist of spirals or rings and straight of hard-drawn steel wire or mild steel rod and maybecircular.Circularcagesandlongitudinalreinforcementshallbeplaced symmetrically withrespect tothethickness ofthe pipe wall.Thespirals shall end ina complete ringat both the ends of a pipe.

Pipes havingbarrel thickness **above 100 mm** shall have double reinforcement cage andthe amount of steel in the outer cage shall be 75% of the mass of the inner cage whilst the total shall conformtotherequirementsspecifiedintherelevanttablesofIS458:2003.Thetotal longitudinal steel per pipe shall be given in the relevant tables of the standard but the distribution shall be such that the round shape of the cage is not disturbed.

Diagonalreinforcementmaybeprovidedinpipesforwhichthecagesarenotwel

dedso asto help in binding the cage securely. It shall, however, be ensured that the clear cover for any reinforcement is not below the limits specified in **6.4 of IS 458.** If diagonal reinforcement is provided, it shall be considered as part of process requirement and shall not be counted against the longitudinal reinforcement and spiral reinforcement. Single reinforcement cage shall be located near the inner surface of the pipe with adequate clear cover.

vii) WaterCuring

Pipes manufacturedincompliance withthis standard shall be water curedfora periodof not less than 2 weeks in case of pipes made from ordinary Portland Cement or Portland slag cement or Portland Pozzolana cement or hydrophobic Portland cement, and not less than 1 week in case of pipes made from rapid-hardening Portland cement or 53 grade ordinary Portland cement. Pipes may be water-saturated material or by a system of perforated pipes, mechanical sprinklers,poroushose,orbyanyotherapprovedmethodthat will keepthepipe moistduringthespecifiedcuringperiod.Inthecaseoflargepipeprojectingpartl yabovethe water level, the projected portion shall be kept wet by any suitable means.

Dimensions

The internal diameter, wall thickness, length of pipes, minimum reinforcements and strength test requirementsfordifferentclassesofpipesshallbeasspecifiedintherespectivetableso fIS458.The manufacturer shall inform the **BWSSB** of the effective length of spigot and socket that he is able to supply.

Tolerances

Thefollowingtolerancesshallbepermitted:

Sr. No.	**Dimensions**	**Tolerances**
i)	OverallLength	:±1% ofStandardLength.
ii)	InternalDiametersofPipes	
j)	Uptoendincluding 300mm	:±3 mm
k)	Over300mmanduptoandincluding600mm	: ± 5mm
l)	Over600mm	:±10mm
iii)	BarrelWallThickness	
m)	Uptoendincluding 30mm	:+2mm−1mm
n)	Over300mmanduptoandincluding50mm	: +3mm −1.5mm
o)	Over50mmanduptoandincluding 65mm	:+4mm−2mm
p)	Over65mmanduptoandincluding 80mm	: +5mm− 2.5mm
q)	Over80mmanduptoandincluding 95mm	:+6mm−3mm
r)	Over 95mm	: +7mm− 3.5mm

Note:

Incaseofpipeswithflexiblerubberringjoints,thetoleranceonthickness neartheendswill have to be reduced. Near the rubber ring joints, the tolerance on thickness shall be as given in Tables 13 to 19 of IS:458.

Workmanshipandfinish

i) Finish

Pipesshallbestraightandfreefromcracksexceptthatcrazecracksmaybepermitted Theendsof the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench, no opening between ends in contact shall exceed 3 mm in pipes up to 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter

The outside and inside surfaces of pipes shall be dense and hard and shall not be coated with cementwash.Theinsidesurfaceofpipeshallbesmooth.Forbetterbond theinnersurfaceofthe collar may be finished rough.

Thepipesshall befreefromdefectsresultingfromimperfect gradingoftheaggregatemixingor moulding.

Pipesshallbefreefromlocal dentsorbulgesgreaterthan3.0mmindepthanddentsandbulges shall not be extending over a length in any direction greater than twice the thickness of barrel.

Pipesmayberepaired,ifnecessary,becauseofaccidentalinjuryduringmanufactur eofhandling and shall be accepted if in the opinion of the BWSSB, the repairs are sound and appropriately finished and cured, and the repaired pipe conforms to the requirements of this specification.

ii) DeviationfromStraight

Thedeviationfrom straightinany pipethroughoutitseffective length,testedbymeansofa rigidstraightedgeasdescribed inIS3597shallnot exceed,foralldiameters,3mm for every meter run.

Tests,sampling,inspectionandmarking

AllRCCS/SNon-pressurepipesaretobetested,forthenumbers/ scaleofsamplingandinspected and clearly marked as per the relevant clauses (10, 11 and 12) in IS:458-2003.

Transportandhandlingofpipesandother materials

ThespecificationfortransportandhandlingofpipesshallconformtoIS:783-1985unless otherwise specified.

d) TheR.C.C. pipes,base plates, manholeframes andcovers,boltsand nuts,clampsetc.,shall be transported by the contractor for laying and construction work at the respective sites of work at his own cost.

e) Itisessentialto

transport,handleandlaythepipes,materials,etcinsuchamannerasnot to cause damage. In lorry/truck shipments, the pipe shall be supported in wide cradles of suitablypaddedtimbershollowedoutonthesupportingsurfacetofitthecurvature of

pipe,andallchains,calves,orotherequipmentused forfastening theloadshallbe carefully padded. For smaller diameter pipes, sand or saw-dust filled bags may be used insteadofhollowedouttimbers.Pipesshallnotbethrowndownfromthelorries /trucks nor shall that be dragged or rolled along hard surfaces. Slings of canvas or equally non- abrasive materials of suitable width or special attachment shaped to fit the pipe ends shallbe used for lifting and lowering pipes so as to eliminate the risk of damage.

f) Great care shall be taken in handling the pipes right from the first operation until they are laid and jointed. The contractor shall be responsible for any loss or damage to the pipes and other materials.

Permissiontolaypipe,concrete

When any portion of the excavation shall have been carried down to the necessary depth, the contractorshallobtainpermissionfromtheEngineerbeforecommencingthelayingof pipesor concrete.

Layingandjointingofsewers

c) The specificationforlayingand jointingofRCCpipesshallconformgenerallyto IS:783-1985 and amendments thereon.

d) These specifications cover the work of laying all RCC pipe lines, underground and above ground, including all civil works required for the same.

e) The Contractor shall manufacture the pipes for a length of maximum 500 m at a time. All these pipes should not be conveyed to the site at a stretch, Contractor shall carefully convey and stack the pipes along the side of the road at every two manhole lengths only. and this should not affect the traffic and pedestrians.

LayingandJointingofR.C.C. pipes

i) Before commencing the work of pipe laying the contractor shall study the longitudinal sectionandotherrelevantdetailsofthepipelineforthesection/reachconcerne d. Pedestals/ cradles to be provided for shall be constructed before commencing the pipelaying work in any section, If the pipes are required to be wholly encased in concrete encasement of the pipes shall be done as per the method decided by the Engineer.

j) The contractor should check all pipes, rubber rings and other materials

beforehand and satisfy himself and intimate, the department if any defects are noticed or if the quality is found to be not to standard.

k) Allpipesshallbecarefullyhandledandloweredintothetrenchbymeans ofproper methods of handling. The pipes shall be handled by flat rubber belts.

l) Socketshouldfacetheoppositetothedirectionofflow.Pipeshallbenormallylaidso that spigot end enters the socket face. The socket and spigot ends of the pipe shall becleared of all extraneous matter especially of clay and grease. Rubber ring shall be cleanand dry.

m)Allthepipesshallbelaidperfectlytruebothinlineandgradespecifiedinthedrawings. the rubberringsshallbekeptevenly positionedon the spigotgroove andwhensatisfied thatthepipeandrubberringarecorrectlypositioned,thepipeshallbeforced/pushed wellrighthomeofthefulldepthofthejointbymeansofuniformlyappliedpressure withtheaidofajackorsimilarappliance.Therubberringshallconformto1S:5382- 1985. Inside the joint, the two pipe ends shall be in close proximity. Properly fitted temporarywoodenstoppersshallbeprovidedandconstantlyusedtoclosetheendsof all in completed pipe lines.

n) Bailing or pumping out of water from trench including shoring,strutting and removingslush while laying, jointing and testing shall be done by the contractor. Caving, sliding, underpinning,floatationaresomeofthefeaturestobekeptinviewbythecontractor andheshalltakeallrequired/necessaryspecialprecautionsduringthecourse of execution. The contractor shall see that water will not be allowed to accumulate in open trenches, where work is in an incomplete stage. Precautionary works such as blank-flangingtheopenendsofthepipelineshallbetakenupatthecontractor'saccountand no separate payment will be made for the same. Should any section of the pipe line float during thecontractperiod,theentirecostoflayingitagaintothecorrectlineandlevel shall be to the account of the contractor.

o) Blankflanges
Blank flanges shall be provided at all ends left unattended for the temporary closure ofwork. Attheend ofaday'swork, also suitableclosuresshallinvariably beprovided at the open end or ends to protect the pipe line from ingress ofsub-soil water, mud, muck, debris, dust etc.

p) Wherever pipe laying work is done from two faces and/or has to be done

in brokenstretchesduetoanydifficultymetwithatsite,tocarryoutfinalconnection,the contractor should take all special precautions such as maintaining the levels, grades, alignmentkeepinginviewthelengthofpipes.Ifanymistakeorerroroccurs,the contractorshallrelaytheentirestretchathiscost.Anylossesordamageseither topipes or other material thereupon shall be at the contractor's expense and necessary recoveries shall be made.

i)Precautionsagainstfloatation

Whenpipelinelaidundergroundorabovegroundinalongnarrowcuttinggets submerged in water collected in the trench or cutting, it is subjected to anuplift pressure due to buoyancy and is likely to float, completely or partly empty. In the design of pipelines, provision is made to safeguard against floatation by providing sufficient overburden or by providing sufficient dead weight by means of anchorblocks.

In the case of the work extending into the monsoon season, however, special care and precautions are necessary during the progress of work on this account. The work of providinganchorblocksandrefillingthetrenchestotherequiredlevelandcompactingthe same etc. shall always be done as soon as the pipeline has been laid.

The contractor shall see that water will not be allowed to accumulate in open trenches, where workis inan incomplete stage, precautionaryworksuch as blank-flangingthe open endsofthepipelineandfillingthepipelinewithwateretc.shallbetakenasdirectedbythe Engineer. Such works shall be to the contractor's account and no separate payment will be made for the same. A two metres over burden shall be maintained at all times. Where this overburden is not available, anchor blocks have to be provided.

Protectionofpipelineagainstfloatationduringthecontractperiodshallbethe responsibility of contractor. Should any section of the pipe line float due totheir negligence etc, the entire cost of laying it again to the correct line and level shall be to his account.

Spigotandsocketjoint(flexible)

The RCC pipe with rubber ring accurately positioned on the spigot shall be pushed well home intothesocket ofthepreviouslylaidpipebymeansof uniformlyappliedpressurewiththeaidofajackor similarappliance.The RCCpipeshall be of spigot andsocket type and rubber ringshall beused, and manufacturer’s instructions shall be deemed to form a part of these Employer’s Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

Cleaningof pipes

AssoonasastretchofRCCpipeshasbeenlaidcompletefrommanholetomanholeorfora stretchas directed by Engineer, Contractor shall run through the pipes both backwards and forwards a double

discorsolidorclosedcylinder75mmlessindiameterthantheinternaldiameterofthepipes.The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Engineer considers that damages may have been causedtothepipelines,heshallbeentitledtoorderthestretchtobetestedimmediately. Shouldsuch test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by the Engineer.

It shall alsobe ascertainedbycontractor thateach stretch frommanhole to manhole orthestretch as directedbyEngineerisabsolutelyclearandwithoutanyobstructionbymeansofvisualexamination of the interior of the pipe line suitably enlightened by projected sunlight or otherwise.

Testingatworksite

After laying and jointing of RCC pipes is completed the pipe line shall be tested at work site as per thefollowingEmployer'sRequirementsandasdirectedbytheEngineer.Allequipmentfortestingat work site shall be supplied and erected by contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be contractor's responsibility and shall be rectified by him to full satisfaction of the Engineer. Water used for the test shall be removed from pipes and not released to the excavated trenches. The details of testing are given in other sections of this chapter below.

SECTION-6

DOUBLEWALLCORRUGATEDPIPES(DWCPIPES)

General

DWCpipesshall conformtoIS16098(Part-2).Thepipesshall bewithnon-smoothexternal and smoothinternalsurfacebasedonPEstructuredwallpipingsystemfornon-pressureunderground sewerage system.

DWCpipesareclassifiedonringstiffnessandshallbedesignatedinthefollowingnominalring stiffness classes (SN):

a) DN≤500: SN4,SN8orSN16

b) DN>500: SN2,SN4,SN8orSN16m

Underthiscontract,itisproposedtoadoptClassSN8ringstiffnessasperIS16098(Part-2).

Compositionofthematerial

The material from which the pipe is produced shall consist substantially of polyethylene (PE) or polypropylene (PP) to which may be added those additives that are needed to facilitate the manufacture of the pipes as per Tables 1, 2, 3 and 4 of IS 16098 (Part-2) and conforming to requirementsofIS16098(Part-2).In general,(i)basedensityshallbe≥0.930g/ccinaccordancewith IS7328(ii)Meltflowrate(MFR)≤ 1.6g/10minat 190 ^{0}Cand5Kgloadingmassandshall beasper IS 2530 (iii) Thermal stability (oxidation induction test at 200 ^{0}C)≥ 20 min.

Rework material

Clean, reprocess able material generated from a manufacturer’s own production according to IS 16098 (Part-2) may be used if it is derived from the same raw material as used for the relevant production.Reprocessablematerialobtainedfromexternalsourcesandrecyclablematerialshallnot be used.

WallconstructiondesignatedastypeB

Outside Profiled and Inside Smooth Profile Section: A pipe with a smooth internal and profiled externalsurfaceformingafinisheddoublewalledprofileshallbeconfirmingto IS16098(Part-2).

Dimensionof pipesand fittings

DiameterofPipe

Theinternaldiameter(DN/ID)shallbeasperClNo.6.3.1,Table5ofIS16098(Part-2).

LengthofPipe

Theeffectivelengthofpipeshallbenotlessthanthatspecifiedin ClNo.6.3.2andas givenin Fig. 2 of IS 16098 (Part-2).

DiametersofPipesandSpigotsof Pipes

ThenominalsizesandminimummeaninsidediameterforDN-IDseriesarespecifiedinClNo.6.3.3, Table 5 of IS 16098 (Part-2).

The outside diameters of the DN-ID series pipes and spigots intended to have jointing dimensions as pipesaccordingIS16098(Part-2)shallcomplywiththeoutsidediametersandtolerancesasspecified by the manufacturer.

DiametersandJointingDimensionsofSocketsandSpigots

Minimumrequirement regardingthe socket and spigot dimension are specified inCl No 6.3.4,Table 5ofIS16098(Part-2)andJointswiththeelastomericsealingringshall bepositionedinthesocketof pipes.

WallThicknessof Spigot

When the spigot has the same design as the pipe, the wall thickness requirements for the correspondingpipedimensionandconstructionshallbeasperClNo.6.3.5ofIS16098(Part-2).

Wallthicknessofsockets&spigotsandjointdesign requirements

In addition to the minimum required wall thickness of sockets and spigots as per Cl No. 6.3.5 of IS 16098-(Part-2),theirringstiffness,whendeterminedinaccordancewithTable10ofIS-16098shall conform to the requirements of 6.3.5.1.1 of IS 16098 (Part-2).

Physicalcharacteristicsforpipesandfittings

Appearance

The structured outer layer of finished pipes shall be uniformly corrugated. The

inner layer shall be smooth and plain. Both layers shall be free from any visual defects such as cracks, blisters, foreign inclusionsandanyothervisualirregularitieswhichmaycauseharmtoitsconstructionintegrities.The

innersurfacemayreflectslightshallowundulationsandoverallshallbeasperClNo.7.1ofIS16098 (Part-2).

ColourofFinishedPipes

Theinnerandouterlayerofpipesshallbecolouredthroughout.Theoutsidelayerofpipesandfittings should preferably be black, orange brown or grey and overall shall be as per Cl No.7.1.1 of IS 16098 (Part-2).

Physical Characteristics

Whentested inaccordance withthe test method specified inTable 6 (Physical Characteristics of PE Pipes)usingtheindicatedparameters,thepipesshallhavephysicalcharacteristicsconformingtothe requirements given in Table 6 of IS 16098 (Part-2).

Mechanicalcharacteristics

MechanicalCharacteristicsofPipes

The ring stiffness, Impact Strength, Ring flexibility and Creep ratio for the pipes when tested in accordancewiththetest methodspecifiedinTable10usingtheindicatedparameters,pipeshallhave mechanical characteristics conforming to the requirements given in Table 10 of IS 16098 (Part-2).

Joints

Elastomeric sealing rings used for joining of pipes shall be free from substances that can have a detrimental effect on the pipes. Elastomeric sealing rings shall be in accordance with one of the type (Type 1 to Type 6) of IS 5382 based on the manufacturers recommendation. A test report or conformitycertificateshallbeprovidedfromthemanufactureroftheseal ingringforconformitytoIS 5382.

Performancerequirements

When tested in accordance with the test methods specified in Cl No.9, Table 12, for (i) Tightness of Elastomericringseal, (ii)watertightness,resistancetointernalpressure,(iii)Resistancetocombined temperature cycling and external loading and other parameters as per the Cl No.9 of Table 12, the joints and the system shall have characteristics

conforming to the requirements given in Table 12 of IS 16098 (Part-2).

Sampling,frequencyoftestsandcriteriafor conformity

AcceptanceTest

AcceptancetestsarecarriedoutonsampleselectedfromalotasperISinaccordancewithTable13 (for pipes) of IS 16098 (Part).

TypeTest

Typetestingshall beinaccordancewithTables15ofIS16098(Part-2),asapplicable.Alltestsare requiredtobecarriedouteitherinanin-houselaboratoryoratanauthorizedthirdpartylaboratory.

SamplingLot

Allpipesofthesamesize,samegradeandmanufacturedessentiallyundersimilarconditionsshall constitute a lot. These pipes shall be selected at random from the lot and in order to ensure the randomness of selection, a random number table shall be used as per IS 4905.

IntheabsenceofarandomnumbertableproceduregiveninTable19ofIS16098(Part-2) may be adopted.

Conformance

Thelothavingsatisfieddimensionalandvisualrequirementsshallbetestedforotherrequirements with the sample size selected as per Table 20 of IS 16098 from the lot for conformance as per IS 16098(Part-2).

Marking

GeneralMarkingshall belabelled,printedorformeddirectlyonthepipe,insuchawaythatafter storage, weathering and handling the legibility shall be maintained.

MinimumRequiredMarkingPipes

Each pipes shall be marked at intervals of maximum 3 m, at least once per pipe, with the following information:a)Manufacturer’sname/Trade-mark;b)Diameterseries,nominalsize;c)Stiffnessclass; d)Material;ande)Lotnumber/batchnumbercontaininginformationregardingperiodofmanufacture (f)NameoftheClient:BWSSB, Bengaluru.

BISCertificationMarkingEachpipeshallalsobemarkedwiththeStandardMark.

Transportation,handling,installationand jointing

Transportation

The arrangement of loading the pipes in a telescopic manner is advised, that is, smaller diameters insertedintothenext highersizesofpipesuptotheheight of2.5minatruck.Whileloadingthepipes into the truck, care should be taken that the spigot/coupler end should be arranged alternatively in the corresponding layer so as to avoid the damage to the coupling/socket-end.

Handling

Following recommendations shall be followed while handling the pipes: a) Pipes shall be smoothly loweredtotheground.b)Pipesshouldnotbedraggedagainstthegroundtoavoidtheda magestothe coupler/ pipes. c) 900 mm and larger diameter pipes are carried with slings at two points spaced approximately at 3 m apart. d) For smaller diameters (450 mm to 900 mm, both exclusive) one lift point shall be sufficient. e) For diameters smaller than or equal to 450 mm, manual labour can be used. f) Loading boom or fork lift should not be used directly on or inside pipe.

PipeStorageat Site

Stockpiling shall be done temporarily on a flat clear area as per IS 16098(Part-2). For avoiding collapse of stacks, wooden posts or blocks shall be used. Stacking shall not be higher than 2.5 m. Whilestacking,alternatethesocket/couplerendsateachrowofstackedpipesasperIS 16098(Part- 2).

Constructionmethods

Trench Preparation

Dimensions: The width ofa sewer trench dependson the soil condition,type of side protection and the working space required at the bottom of trench for smooth installations. Increase in width over requiredminimumwouldundulyincreasetheloadonpipeandcostofroadrestoration. Considering all above factors, the minimum trench width is specified as per Table 21 of IS 16098 (Part-2) and given below shall be adopted.

MinimumTrenchWidths

(Clause A-4.1.1)

S.	Pipe Diameter	TrenchWidth

No.	(inmm)	(inM)

S. No.	Pipe Diameter (inmm)	TrenchWidth (inM)
1	75 to 200	0.6
2	250	0.7
3	300	0.8
4	400	0.9
5	600	1.2
6	800	1.3
7	900	1.6
8	1000	1.8
9	1200	2.0

Excavation:

Excavationofsewertrenchesshallbeinstraightlinesasmuchaspossible andtothe correct depths and gradients as specified in drawings.

Excavatedspoilsshallnotbedepositedinthenearproximitytopreventthecollapseofsideof the trenches. The sides of the trench shall, however, be supported by shoring (where necessary) to ensure proper and speedy excavations and concurrently ensuring necessary protections to contiguous structures. In the event, the presence of ground water is likely to cause instability in soil conditions, sump pumping/a well point system/any other suitable dewatering system may be adopted for lowering of water table below the requisite trench bed level. If excavation is made deeper than necessary the same shall be filled and compacted at the contractors cost.

Shoring: ***mild steel sheet piling: As per the site requirement and as directed, the protective shoring works shall be strong enough to prevent caving in of trench walls or subsidence of contagious areas adjacent to trench.***

Undergroundservices:

Theundergroundpublicandprivateutilityservicesexposedduetotheexcavationshallbe effectively supported under the guidance of the owners of such services.

Dewatering: Sewer installationtrenches shall be adequately dewatered fortheplacement of pipe at proper gradient till the pipe is integrated through socket and spigot joint assembly with the

already laid segment.

Precautions are to be taken to arrest floating of installed sewer segments against buoyant forcesincaseofsuddenaccumulationofwaterinthetrench.Thediameterwisem inimum cover necessary to counteract the buoyant forces is given in Table 22.

Forexceptionalcasesofhigherlevelofgroundwater,additionalanchoringatequ alintervals would be necessary and shall be done as per the contract provisions.

Bedding: ***For maintenance of sewer slopes the initial backfill envelop with sand or gravel or as per site requirement and as directed would be sufficient. In the event, anchorage becomes imperative the transverse concrete anchorage blocks spaced at suitable interval shall also act as chairs for defining and maintaining the sewer slopes.***

Laying:

a) Makethetrenchreasonablyfreefromgroundwaterandotherliquids.

b) Placethepipeonthetoplevelcross-strutsofthetimbershoring/ mildsteelsheetpiling frame work.

c) Dismantleone/ twocrossstrutsandlowerthepipestotheimmediatelowerlayerofthe cross struts and re-fix thestrutsimmediately(in case ofshoringforsupportingthetrench sides).

d) Inthesameabovemanner,reachuptotheinitialbackfillingandplacethepip eatproper slope.

e) Ensureanchorage,ifany,afterlaying.

Jointing: Variousmethodsforjointingsuchasspigotandsocketsareused.

Themouldedsocketwillhaveasuitableinternalsurfacewithprofilesribsforinse rtionofthe next pipe into it. The socket end of the pipe to be inserted will have corrugated outer layer. Onfirstvalleysegmentofcorrugatedpipe(destinedtobepushedintothecoupler socket)one elastomeric rubber ring needs to be placed which is pushed into the coupler socket. This provides sufficient gripping lock and leak proof joint.

For quality connections following steps are to be ensured, failing which the performance aspects are to be severely compromised: a) The non-coupler-socket end needs to be thoroughlyclearedandshall befreefromanyforeignmaterial.b)Useacleanragorbrushto lubricate the non-coupler socket end with lubricant.

(c)Clean and lubricate the coupler end (spigot) of the pipe to be laid in similar manner. d) Lubricate the exposed gasket in the same manner with pipe lubricant. e) Keep the lubricated non-coupler end free fromdirt, backfill material, and foreign matter so that the joint integrityis not compromised. f) Push the coupler/socket into non-

coupler/spigot and alignproperly.Alwayspushcouplerendintonon-couplerend.Forsmallerdiameterpipes simple manual insertion shall be sufficient. In every methodology, it should be ensured that the coupler end is adequately ‘homed’ within non-coupler end to ensure installation and tight joining seal. Therefore, prior to insertion always place a homing mark on appropriate corrugation of the noncoupler end.

ConstructionofBackfillEnvelopeandBackfillingoftheTrenches:

These pipes and well compacted backfill envelope work together to support soil and traffic load.Ingeneral,materialusedforconstructionofbackfillenvelop aroundthepipecomprises the following: a) Initial backfill; b) Side fill; and c) Top backfill.

The material for backfill envelop shall be as per the structural design of flexible buried conduit.Itcanbethesamematerialthatwereremovedinthecourseofexcavatio noritcanbe finesand/course sand/gravel oras per site requirementand asdirected.The remainingportion of backfilling shall be the materials that were removed in the course of excavation. These materials shall consist of clean earth and shall be free from large clod or stone above 75 mm, ashes, refuse and other injurious materials. After completion of laying of pipes, etc, first the backfill envelopeshall beconstructedasperdesignaroundpipe.Voidsmust beeliminatedby knifing under and around pipe or by some other technique and compacted with necessary watering, either by hand rammers or compactors to a possible maximum level of proctor density. Backfilling shall start only after ensuring the water tightness test of joints for the concerned sewer segments. However, partial filling may be done keeping the joints open. Precautionsshallbetakenagainstfloatationasperthespecifiedmethodologya ndthe minimum required cover.

Listof approvedmakes

Thenamingofamanufacturerinthisspecificationisnotintendedtoeliminateco mpetitionor prohibit qualified manufacturers from offering Pipe/equipment.Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

Inordertoachievestandardizationforappearance,operation,maintenancean dmanufacturer's service, to the greatest extent possible, shall be the end products of one (1) manufacturer.

	Pipes	**MakesofEquipment**
	DWC Pipes	PrincePipingSystems,Mumbai.
		GeminiPipes,Jaipur,Rajasthan,India
		AlomPolyExtrusionsLtd,Kolkata,WestBe ngal

Note-

1:IntheeventthatthecontractorwishestoproposealternatevendorfortheDWCpipes mentioned above, he shall submit the following during detailed engineering:

1) Demonstratethattheproposedmakesare“Superior/Equivalent”totheapprovedmakes.

2) Submitqualitycertificatesthatthepipes/equipmentadheresto.
3) Submitproductbrochuresfortheproposedequipment.
4) Atleast10successfulindividualinstallations/Sewerlayingofsimilarsizeasperthiscontract.
5) Manufacturertoprovidefullcontactinformationforeachreferenceaspartoftechnicalbid.

SECTION-7

DUCTILEIRONPIPES(DI)

ManufactureofPipe

DIpipes (ClassK7 &K9)and fittings(ClassK12) shallbein accordance with IS: 8329and IS: 9523. Pipes and fittings shall be procured from reputed manufacturers with Engineer's approval. Engineer shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and for witnessing the testandmanufacturing.ForthegravitysewersDIpipesofclassK7shallbeusedandfor thepumping mains DI K-9 Class pipes shall be used.

AlltestsspecifiedeitherinthisspecificationorintherelevantIndianStandardsspecifie daboveshall be performed by the supplier/Contractor at his own cost and in presence of Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to Engineer.

If the test is found unsatisfactory, Engineer may reject any or all pipes and fittings of that lot. The decisionofEngineerinthismattershallbefinaland bindingontheContractorandnotsubjecttoany arbitration or appeal.

Thepipesandfittingsshallbestripped,withallprecautionsnecessarytoavoidwarping orshrinking defects. The pipes and fittings shall be free from defects. Any defect in pipes and fittings in the opinion of Engineer shall be rejected and shall be replaced by new one.

Inthecaseofspigotandsocketpipesandfittingsthesocketshallbewithoutthecentre ring.

In the case of flanged pipes, the flanges shall be at the right angles to the axis of the pipe and machinedonface.Theboltholesshallbedrilledandlocatedsymmetricallyoffthecente rline.The bolt hole shall be concentric with the bore and bolt holes equally spaced. The flanges shall be integrallycast withthepipesandfittingsandthetwoflangesofthepipeshallbecorrectlyaligned.

Materials

Thematerialsusedinthemanufactureofpipesandfittingsshallcomplywithrequirem entsspecified in IS: 8329 and IS: 9523.

Dimensionsandtolerances

Theinternaldiameter,thicknessandlengthofbarrel,dimensionsofpipesandfittingss hallbeasper relevant tables of IS: 8329/IS: 9523 for different class of pipes and fittings. Each pipe shall be of uniform thickness throughout its length.

Thetolerancesforpipesandfittingsregardingdimensions,mass,qualityanddeviation sfromstraight line in case of pipes shall be as per IS: 8329/IS: 9523.

Testingofpipesduringmanufacture

(a) MechanicalTests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in IS: 8329 / IS: 9523. The frequency and sampling of tests for each batch of pipes shall be in accordancewithIS:8329.Thetestresultssoobtainedforallthepipesandfittings ofdifferent sizes shall be submitted to Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS: 8329/IS: 9523.

(b) BrinellHardnessTest

ForcheckingtheBrinellhardness,thetest shall becarriedout onthetest ringorbarscutfrom the pipes used for the ring test and tensile test in accordance with IS: 1500. The test shall comply with the requirements specified in IS: 1500/IS: 8329.

(c) Retests

Ifanytest piecerepresentingalot failsinthefirstinstance,twoadditionaltestsshallbemade on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted.Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

(d) HydrostaticTest

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in IS: 8329 / IS: 9523 for a period of minimum 15 seconds, during which the pipes shall bestruckmoderatelywith a700 ghammer forconformation ofsatisfactorysound.They shallwithstandthepressuretestwithoutshowinganyleakage,sweatingorothe rdefectofany kind. The hydrostatic test shall be conducted before surface coating and lining.

Layingofthepipe

Laying of DI pipes shall conform to the Code of practice of IS: 12288. Pipes shall be laidunderground with a minimum earth cover of 1m. Pipes shall be generally laid in sections of 300 m each. Laying of pipes shall be as per Standard Specifications for Procurement of Project Works. All pipes, fittings and material shall be tested andapproved by the Engineer before beinglaid. Anypipes, fittings or material placed before they are tested and approved shall be removed and replaced with tested and approved material. Before laying the pipe, necessary bedding shall be provided wherever required.Polyethylenesleeveswoundedpipesshallbeusedforwaterloggedareasasp erspecification and as directed by the Engineer.

Jointingofpipes

(a) General

Jointing of DI pipes and fittings shall be done as per IS: 12288 and manufacturer's recommendations. After jointing, extraneous material, if any, shall be removed from the insideofthepipe.Rubbersealingrings/gasketsusedforjointingshallconformtoIS:638,IS: 12820 and IS: 5382.

(b)SpigotandSocketjoints

Theseshallhavesockets,whichareintegralwiththepipeandincorporateanelastomeric rubber ring gasket conforming to IS: 12820.

The gaskets/sealant used for joints shall be suitable for water conveyance.In jointing DI pipesandfittings,theContractorshalltakeintoaccountthemanufacturer'srecommendations as to the methods and equipment to be used in assembling the joints.In particular the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, so that the rubber ring as per IS: 12820 and IS: 5382 is correctly positionedinline,beforethejointismade.Therubberringsandanyrecommendedlubricant shall be obtained only through the pipe, supplier or as otherwise directed by the Engineer.

(c) GasketsforFlanges

Allgasketsusedbetweenflangesofpipesshallbeofnaturalrubberconformingto IS:638of thickness 3 mm suitable for clear water conveyance and as specified by manufacturer.

(d) Flangedjoints

These shall be of PN 1.0 rating and shall comply with dimensions and drilling details as specifiedinIS:8329.Theseshallhaveisolationgasketsbetweentheflanges,isolationsleeves around all bolts and isolation washers under all bolt heads and nuts. All material shall be supplied by a reputed manufacturer and shall be approved by the Engineer.

Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The recommended bolting torque to be followed for assembling flanges shallbeasspecifiedinmanufacturer'sinstructions.Thepracticeoffullytightening thebolts one after another is highly undesirable.The bolts shall be of mild steel unless otherwise specified. They shall be coated with coal tar epoxy coating after tightening.

Coatings

(a) General

Unless otherwise specified, DI pipes and fittings shall be coated with Bitumen in accordance withrelevant IS specifications.All buried DIpipes and fittings shallalso have factoryorsite appliedpolythenesleeving.Coatingshallnotbeappliedtopipeandfittingsunlessits surface

isclean,dryandfreefromrust.Pipecoatingsshallbeinspectedatsiteandanydamageor defective areas shall be made good to the satisfaction of the Engineer.

(b) Bitumencoating

Bitumen coating shall be of normal thickness of 75 microns unless otherwise specified.It shall be cold applied compound complying with the requirements of relevant Indian standards,suitablefortropicalclimates,factoryappliedinaccordancewiththe manufacturer's instructions.

Damagedareasofcoatingshallberepaintedonsiteafterremovinganyremaining loose coating and wire brushing any rusted areas of pipe.

(c) Cementmortarlining

All pipes and fittings shall be internally lined with cement mortar in accordance with IS: 11906.Cement mortar lining shall be applied at the factory in conformance with the above-mentionedstandards.ThecementusedshallbeHighAluminaCement.Noadmixturesinthe mortar shall be used without the approval of the Engineer.

Pipeliningsshallbeinspectedonsiteandanydamageordefectiveareasshallbe madegood to the satisfaction of the Engineer.

Liningshallbeuniforminthicknessall alongthepipe.Theminimumthicknessoffactory applied cement mortar lining shall be as per IS: 11906.

(d) Marking

MarkingshallbedoneasperIS:8329andIS:9523oranyotherrelevantIScodes.

Carting& handling

Pipes and fittings/specials shall be transported from the factory to the work sites at places along the alignment of pipeline as approved by Engineer in lengths not more than the length of the transporting vehicle. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading. Every care shall be exercised in handling pipes and fittings/specials to avoid damage. While unloading, the pipes and fittings/specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes and / or by any other approvedmeans.Paddingshallbeprovidedbetweencoatedpipes,fittings/specialsandtimberskidsto avoiddamagetothecoating.Suitablegapsbetweenpipesshouldbeleftatintervalsinordertopermit access fromone side to the other. As far as possible, pipes shall be

unloadedon one side of the trench only.The pipes shall be checked for any visible damage (such as broken edges, cracking or spoiling of pipe) while unloading and shall be sorted out for replacement. Any pipe, which shows damage in the opinion of Engineer, shall be discarded and replaced by new one without extra cost. Dragging of pipes and fitting/specials along road or pipeline alignment shall be prohibited.

Methodsofmeasurementforseweragesystem

5. For manufacture, supply and delivery of pipes, measurement shall be taken for actual number of pipes multiplied by the standard length.
6. Layingandjointingof pipes andspecialsand valves will bemeasuredinlinear meters along the centre line of the pipesactuallylaid,jointed andtestedand will belimited tothe number of pipes x standard length + part length of pipe if any including specialsand work is including the cost of rubber ring.

SECTION–8

ACCEPTANCE TESTS

CheckforObstruction

a. As soon as a stretch of pipes whether of RCC Pipes or DWC or DI Pipes has been laid Complete from manhole to manhole, the Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75mm less in diameter than the internal diameter of the pipes. The open end of an incomplete stretch of pipe lineshall be securely closed as may be directed by the Engineer to prevent entry of mud or siltetc.

d. If as a result of the removal of any obstruction the Engineer considers that damages mayhave been caused to the pipe lines, he shall be entitled to order the length to be retested attheexpenseoftheContractor. Should suchretestproveunsatisfactory theContractorshall at his own expense amend the work and carry out such further tests as are required by the Engineer.

e. It shall also be ascertained by the Contractors that each stretch from manhole to manhole is absolutely clear and without any obstruction by means of visual examination of the interiorof the pipe line.

HydraulicTestingofSewers

Immediatelyafter the test withthe double disc or cylinder as mentioned above has been completed andanydefectstherebydisclosedhavebeenmadegood,theContractorshallprovethejointsofthe stretch of under-ground pipes are water tight.

Each section of sewer shall be tested for water tightness preferably between manholes. To prevent changeinalignmentanddisturbanceafterthepipeshavebeenlaid,itisdesirabletobackfillthepipes up to the top keeping at least 90 cm length of the pipe open at the joints. However, this may not be feasible in the case of pipes of shorter length, such as stoneware and RCC pipes. With concrete encasement or concrete cradle, partial covering of the pipe is not necessary.

Ifitisnecessarythatthepipelinesarefilledwithwaterbeforecommissioningtheapplicationof pressure to allow for the absorption by pipe wall as per relevant IS standards.

The Sewers are tested by plugging the upper end with a provision for an air outlet pipe with stop cock. The water is filled through a funnel connected at the lower end provided with a plug. After theairhasbeenexpelledthroughtileairoutlet,thestopcock isclosedandwaterlevelinthe

funnel is raised to 1.5 m above the invert at the upper end. Water level in the funnel is noted after30minutesandthequantity ofwaterrequiredismeasuredatanintervalof10minutestorestore the original water level in the funnel. The pipe line under pressure is then inspected while tilefunnel is still in position. There shall not be any leaks in the pipe or the joints (small sweating ontilepipesurfaceispermitted),any sewerorpartthereofthatdoesnotmeetthetestshallbe emptiedandrepairedorre-laidasrequiredandtestedagain.Theleakageorquantityofwaterto be supplied to maintain the test pressure during the period of 10 minutes shall not exceed 0.2litres/mm dia, of pipes per kilometre length per day. Water and other accessories required fortesting shall be to the account of the contractor. In case of DI pumping/risingmains the hydrotesting of the pipes shall be carried out as per IS 8329 provisions.

TestingofManholes

The entire height of the manhole shall be tested for water tightness by closing both the incoming and outgoingendsofthesewerandfillingthemanholewithwater.Adropinwaterlevelnotm orethan50 mm per 24 hours shall be permitted. In case of high sub-soil water, it should be ensured that there is noleakageofgroundwaterintothemanholebyobservingthemanholefor24hoursafte r emptyingit.

Waterandotheraccessoriesrequiredfortestingshallbearrangedbythecontractorathisown cost.

SECTION9

TECHNICALSPECIFICATIONSFORTRENCHLESSTECHNOLOGY

General Specification

Thesespecificationsareintendedforgeneraldescriptionofqualityandworkmanshipo fmaterialsand finished work. They are not intended to cover minute details. The work shall be executed in accordance with best modern practices and using appropriate techniques of trenchless technology as necessary considering the physical and geotechnical site conditions subject to approval of the Engineer.

The quantities specified in the tender are only approximate and may change depending upon the actualsiteconditionsandtheworkbytrenchlesstechnologyshallhavetobecarriedout atquoted rates only.

Contractor'sobligations

The scope of this component of the contract is ***"design and build"*** pipelineslaid by trenchless technology works like pipe jacking/ pushing, auger boring or micro tunneling and shall cover all equipment,designs,preparatoryworks,safetymeasures,testingandcommissioning etcnecessaryfor trenchless process. If the Contractor intends to use any other trenchless technique, it shall be with prior approval of the Engineer and at no extra cost of whatsoever nature to the Employer. The Contractor may request the Engineer for approval to a specific trenchless technique but Engineer's decisionshallbefinal andbinding. However, the Contractorshall be solelyresponsibleforadequacy and safety of any of the techniques to be used. The Engineer reserves right to consider such alternative trenchless techniques.

The clauses in this section are meant to provide general guidelines and compliance requirements to the Contractor. It does not however relieve the Contractor from taking every other steps and precautionsasdeemednecessarytocompletetheinstallationofthepipelinessuccessf ullywithinthe specified contract period and the amount.

Theobjectiveoftheworkistoprovideandlaysewerlinesmeetingthehydraulicrequire mentsfor future and fulfilling the structural and serviceability requirements.

TheContractor’sshallnotethatthealignmentoftheproposedworksisinvicinityoraffectedby-

- HighwaysincludingexistingCCroadpavementandmajorjunctionsofroads
- Railroadsincludingtracksonhighembankments
- Crossingofmajornalla/drains/watercoursesorincloseviciniyofwaterbodies
- Layingofsewersincongestedareaswheretrafficdiversionisnotpermitted

Furthermore, the consideration that a method permitted as a suitable method of installing the sewers by trenchless technology shall not relieve the Contractor in any way from his prima facie obligation andresponsibilityunderthecontracttosuccessfullyinstallthepipelineswithoutcausi nginterruptions to traffic or inconveniencing citizens or road users and within the specified contract period and contract amount.

The Contractor’s rates in the Bill of Quantities shall be deemed to be for installing the pipelines successfullyincludingallappurtenantand/orancillaryworkswithinthespecifiedcont ractperiod regardless of the method.

ItshallbeobligatoryfortheContractorstocarryoutgeotechnicalandotherinvestigati onsincluding buried services detection by appropriate equipment and satisfy themselves and the Engineer of the adequacy of their testing.

The Employer / Engineer shall not be responsible for any changes in method or equipment necessitatedduringexecutionoftheworkanditshallbecontractor’ssoleresponsibilit ytoensure deployment of proper method and equipment for the work.

The Contractor shall, on his own accord collect information or conduct investigations about likely geotechnical conditions at the site. Any risks assumed by the applicant by solely depending on his currentknowledgeofthesiteoftheinformationcurrentlyavailableonthegeotechnical conditions, buried services, anyphysical obstructions shall beentirelyhis own andhe shall besolelyand fully responsible for any consequential expenses arising as a result of the risk he assumed. He shall not resort to any compensation claim under the contract for differing ground condition that he may encounter as a result of assuming the risk.

Theextentandscopeofthegeotechnicalandotherinvestigationsalongthepipelinerou tewould depend on the type of the equipment and systems that he proposes to use in the project.

TheapplicantshallensurethattheTrenchlessTechnologysystemshallsuccessfullyex

cavateinwide ranging ground conditions, from soft ground, sandy/ silty strata to hard rock strata or strata with boulder or high water table etc. likely to be encountered at the sites. For soft and slushy grounds the

contractorshalladoptappropriategroundimprovementmethodtosuittheconstruction methodas well as to ensure long term stability of pipeline laid during its lifespan.

ScopeofWork

Thescopeofworkunderthiscomponentshallincludebutnotbelimitedtothefollowing:

a. Thorough geotechnical investigations needed for ground assessment and sewer laying using trenchless work.
b. Detection and mappingof buried servicesin vicinityof the proposed alignment and providing a diversion or relocation plan. Temporary diversion of such utilities in consultation with the concerned owners and theEngineer of the Contract shall be at risk and cost of the Contractor.
c. Arrange for permissions from various authorities including railways and pay necessary charges which shall be reimbursed by the Employer at actuals.
d. Construction of shafts/ insertion or access pits for the proposed method using appropriate excavation technology such as well sinking or sheet piling or trench box shoring or any other type of shoring system with detailed design including leaving any type of shoring system in trenches as necessary.
e. Design, manufacture and supply of appropriate type of pipes suitable for the technique to be adopted including RCC Jacking pipes conforming to JSWAS A-2/ A-6, HDPE pipes conforming to IS 14333, DWC pipes conforming to IS 16098 Part 1 and 2, MS pipes for manual pipe pushing/ jacking conforming to IS 3589as acceptable to the Engineer. The scope shall also include all types of carrier pipes besides the sleeve pipes.
f. Construction of manholes and appurtenances as per the specification requirements or as directed by the Engineer.
g. Planning, Detailed Design and construction of interconnection with existing system for connection of flows to the newly laid lines.
h. Excavationasnecessaryapartfromconstructionof shafts
i. Backfillingofexcavatedtrenchesandreinstatementofsurfaces
j. Rectificationofanydamagecausedtoadjoiningstructures
k. Managementofexcavatedmaterialincludingdisposalofsurplusmaterialinenvironment friendly manner as directed
l. Allancillaryandenablingworksneededforthemainworksasmentionedabove
m. Submissionofas-builtdrawings(Softcopyandhardcopiesasrequiredbythe Engineer)

Selectionoftrenchless technique

The technique of trenchless technology to be adopted shall take in to account the physical site conditions, geotechnical conditions, arrangement of pipes,

obligatory requirement of various authorities etc as mentioned below.

Generalapproachforselectionoftrenchlesstechniqueshallbeasunder-

A. Application-
    a. Sewerlinecarryingdomesticsewage
B. Function
    a. Gravity
C. Arrangementofpipes
    a. Incasing-Casing+ Carrier
    b. Directcarrier
D. Dimensionaldetails
    a. Diameter(Jackingand Carrier)
    b. Depthof installation
    c. Obligatorylengthofsingledrive
    d. Limitinglengthofdrive
E. Geotechnicalaspects
    a. Softground (Clayey)
    b. Sandy/ silty
    c. Murum
    d. Soft/Weatheredrock
    e. Hardrock
F. Physicalconditions
    a. Alonganarrowroad
    b. Alongawiderroadwithheavytraffic
    c. Railwaycrossing
    d. HighwaycrossingMajorAccessControlledRoads
    e. River/Nalla/Drains/Watercoursecrossing

G. Materialofcasingandcarrierpipe
    a. RCC/DI
    b. HDPE/DWS
        i. Solid Wall
        ii. DoubleWall
    c. MS
H. Arrangementdesired
    a. CarrierandSleeve
    b. Directinstallation

The Engineer shall in general consider the above aspects for considering appropriate trenchless at aparticular stretch of the work.

Trenchlesstechniquesconsideredsuitableare-

A. Pipepushing/Jacking
B. Augerboring
C. Microtunneling
D. AnyothermethodsuchasHDD

TheContractormay requestforapprovalof the Engineer to any othertechnique butthe Engineer’s decision shall be final and binding on the Contractor.

Terminologyandgeneraldescription

Definitions

For the purpose of this contract document, the technical terms pertaining to micro tunneling works and their functional details are defined below. The definitions herein are meant only as guidelines. If other(ornew)definitionsortechnicaltermsareusedbytheContractorinhissubmittals,theyshallbe clearly defined by him.

Microtunnelling

Micro tunneling is a process of accurately excavating, tunnels for installing underground pipelines, using steerable laser guided remote controlled shields of required diameters .Micro tunneling permits accuratemonitoringandadjustingofthealignmentandlevel(eithermanuallyorautomatically)asthe excavation proceeds.

It is an art of accurately installing pipelines (usually 450mm diameter and above which may be up to 2400mm or even beyond), without digging up of ground surface, using a laser guidedremote controlledshieldsfortunnel boringusingslurryorEPBshieldsandpipejackingtechniqueforlining the bore with the product pipe.

Theprocessofinstallingapipelinebymicrotunnelingandpipejackingsystemcomprisesfive parts:-

(a) Microtunnelboringmachine(Shields)

(b) Automatedspoilremovalsystem

(c)Jackingsystemforpushingthejackingpipeandlateroncarrierpipeasneeded

(d) Guidancesystemtoguidethetunnel excavation

(e) Remotecontrolsystemtooperatetheshieldandotherparaphernaliaequipment.

ManualPipe jacking

It is a process of lininga underground boreformedbymanual excavation under a shieldorother means and pushing specially designed jacking pipes (reinforced concrete or other pipes) simultaneouslyintotheexcavatedtunnelbore,fromashaft(knownasjackingshaft)toa nothershaft (known as receiving shaft).

Augerboring

Auger boring is a process of accurately excavating through ground using flights of augers for spoil removal and drill heads catering to various types of soils ranging from soft ground to rock for installing underground pipelines, using steerable guided remote controlled shields of required diametersgenerally450mmto1000mm.Themethodmayinvolvepipeinstallationusin gsinglestage or multi stage operation using flight of augers and sections of the pipe to be installed.

Atypeofdirectionalandguidedboringmachine,whichusesaugerflightstoremovethe spoilthrough separate casing placed through the product pipeline.

In this system, the excavated materials are continuously removed by an encased screw conveyor attachmentconnectedtotherearofthetunnelcutterface.Bycontrollingthespeedofth escrewaugur andtheoutlet oftheconveyor at thespoildischargepoint,theexcavatedsoilatthetunnel facecanbe kept under a desired balancing pressure to support the tunnel face.

MicroTunnelBoringMachine(shield)

It ismechanized, steerablemini boring machine (or shield) equipped with suitable cutter head in front to excavate smaller diameter tunnelsunder controlled conditions in which the tunnel faceand ground water pressureare continuously balancedas the shield excavates and moves forward. The operationandsteeringoftheshieldareremotelycontrolledwiththeaidoflaserand/ orCCTVsystem.

Therearethreesystemsavailableforthebalancingthefacepressure below:

EarthPressureBalance(EPB)system

Earth Pressure Balance (EPB) is a system in which mechanical pressure is applied to the material at the face and controlled to provide the correct counterbalance to earth pressures in order to prevent heave or subsidence. The system allows excavation of the materials under controlled conditions so thatnofreeflowofsoilorgroundwaterispermittedatthetunnelface.Thespoilremoval rateandthe speed of the shield advancement are thus controlled either fully or semi-automatically.

SlurryPressureBalance(SPB)system

It involves balancing the face pressure using a mechanical tunneling shield with closed face, which employs hydraulic means for removing the excavated material, and balances the ground water pressure by mixing the excavated stuff with water to form slurry. In this system, the excavated materials is continuously mixed with water and or bentonite to convert into slurry and kept under a desired balancing pressure to support the tunnel face. The slurry is pumped to the ground surface wherethesolidsareseparatedfordisposalandthewater ispumpedbacktothetunnelfaceforfurther utilization.

Automatedspoilremovalsystem

Thissystemconveystheexcavatedspoilfromthetunnelfacetothegroundsurfaceford isposal.The spoil removal rate and the speed of the shieldare fully or semi-automatically controlled in such a way to achieve minimal heave or settlement. The common systems available for the conveyance of the spoil and they are slurry system and augur system.

Slurrysystememployshydraulicmeansforremovingtheexcavatedmaterial bymixingtheexcavated stuff with water to form slurry. In this system, the excavated materials is continuously mixed with water and or bentonite to convert into slurry which is pumped to the slurry separation tank at ground level where solids can be separated from slurry and water reused.

IncaseofEPBshields,theremovalofspoilisthroughamethodwhichusedbalancingfor ceofthe excavated soil and the soil is generally removed using augers or belt conveyors.

Jacking System

The jacking system comprise high thrust hydraulic jacks mounted in a jacking frame capable of exerting the required jacking force against a purpose built thrust wall to push the pipes and the shield forwardthroughtheground.Thejackingforceistransferredevenlyto thejackingpipethroughapush ring connected to the pipe.

Guidance System

The guidance system comprises a laser beam device or a theodolite with laser beam attachment or visual guidancesystemsuchasCCTV.Thedeviceisinstalledinthejackingshaft andthebeamisset to the desired level, gradient and alignment.

Some machines have photo sensitive cells on the target panel located at the rear of the shield which converts the laser position into digital data. The data are then electronically transmitted to the operator’scontrolpanelwheredigitalreadoutofthelocationcanbemade.Somemode rnshieldshave built-in capabilities to use the digital data and automatically make necessary steering adjustments to guide the machine to the true alignment and level.

The contractor shall submit complete details of the guidance system he proposes to use and shall incorporate appropriate check points and hold points in the Quality Assurance Manual that he shall implement in the contract. The system shall provide continuous recording of the details of drive capturing various parameters not limited to the horizontal alignment or x & y coordinates, vertical alignment, roll,pitch, torque, jackingforce, laser positions, jackpositions, temperature of hydraulic system,slurry/muckflowrates,etc.andadetailedprintoutofsuchparametersshallbe submittedto the Engineer at the end of every day.

Thelasersourceortheodoliteshallbefirmlysupportedinthejackingpitsothatitisindep endentof any movement that may take place during the micro tunneling and jacking operation.

RemoteControl System

All micro tunneling systems rely on remote-control capability. The control

system monitors and controls the steering of theshield, spoil removal system(slurry or augur or vacuum), jacking system andguidancesystem.Thesystemoperationvariesfromtotallymanualtofullyautomate.Theremote control system is usually housed in portable control cabin.

Thecontrol cabinshallbelocatedneartothejackingpit sothattheoperatorcanvisuallymonitorthe activities in the pit. Where it is not possible to locate the control cabin near to the pit due to space limitations, a CCTV camera system shall be set up in the pit to allow the operator to monitor the activities in the pit.

Forthemanualoperatingsystem,theoperator’sskillisverycrucialforasuccessfulcompletionofthe project.The operator shall have experience of at least 10 years of pilotingmicro tunnelingequipment of which in driving.

The operator shall monitor all the information and continuously feed into the control panel as necessary.He shall be alert at all time and shall observe the crew’s activities and other site activities, evaluate the information and make appropriateoperational decisions.The informationrelayed backto the operator shall be audible, tactile and visual as The MTBM shall have facility to transmit sounds andvibrationsfromtheexcavationfacetotheoperatorstoenablehimtomakeappropriateoperational decisions. Notwithstanding the ability of the equipment to keep automatic drive records, the operator shall monitor and keep record of line and grade of the machine, cutter head torque, thrust, RPM, steering pressures, slurry flow rate, pressures of slurry systems and rate of advancement.

In fully automated system, the machine acquires and evaluates the information and select the operationalstepsforautomaticsteeringofMTBM.Theinformationcollectedshallbeloggedina microprocessor to obtain a printout as necessary.

Thecontractorshallincorporatecheckpointsandholdpointsfortheguidancecontrolsysteminthe Quality Assurance System that he shall implement in the contract.

Supplementarysystems

The supplementary system required for micro tunnelling and pipe jacking operation shall include Muckdisposalsystem,pipehandlingsystems,pipelubricationsystem,Groutingsystem,Guiderails, and Entrance and Exit rings and power supply systems.

Jackingshaft(orJacking Pit)

Jacking Shaft is an important temporary structure from where jacking operation is performed. The shaft is usually rectangular or circular in shape and built using liner plates, sheet piles or timber shoring.Thesizeoftheshaftshallbesuchthatitiscapableofaccommodatingthe jackingequipment (and also the shield), jacking pipe, thrust and entrance wall, Laser source and other paraphernalia or enable construction of manhole or chamber as needed. This may correspond to the position of the manholesandthesizeandshapeshall takecognizanceofthesame.Therequirement forjackingshaft shall take full cognizance of the available working space and intended equipment. If it is intended to have a common shaft for both the drives, the size of shaft shall be selected accordingly.

Receivingshaft(Receivingpit)

A purpose built temporarystructure toreceive andremove the tunnelingshield after its completion of atunnel drive.Theshaftisalsorectangular orcircularinshapeandsmallerthanthejackingshaft.The size shall be sufficient enough to accommodate the tunneling shield when it emerges into shaft after completion of a tunnel drive or construction of manhole or chamber as needed.

Footprint

The footprint of a micro tunnel drive shall be taken as the net area occupied by the jacking or receiving shafts. The size of the footprint depends on many factors including the microtunnelling systemandthelengthofjackingpipeused.Thefootprintrequirement shallbeanimportant factor, especiallyincongestedandnarrowroadswhenselectingthemicrotunnellingsystemf ora project.

Thrustwall

Thrust wall is a temporary concrete or steel structure built within the jacking shaft to transfer the jackingforcetothegroundduringjackingoperation.Thejackingshaftsmayoften havemorethana singlethrust wall andeachthrust wallshallbeperpendicularandsquaretothepipelinetobejacked. The thrust walls shall be in good contact with the soils behind so that wall can transmit the

jacking force effectively to the ground without affecting the shoring system.

Alltheaffectedthrustwallshallbedemolishedfullyorpartlyaftercompletionofjacking operation involving in that wall.

EntranceRing

A steel flange fitted with a rubber seal (a 10mm to 20mm thick circular rubber gasket whose outside diameter is same as that of the steel flange and the inside diameter is smaller than that of the jacking pipe) installed perpendicular to the pipeline at the entrance. The purpose of the rubber seal is to preventtheslurryorgroundwaterfromenteringintotheshaftthroughthepipeentranc e.Theentrance seal shall be capable of withstanding anticipated pressure of the pressurized slurry with bentonite and/or the hydrostatic pressure

Exit Ring

Thisissimilartotheentranceringexceptthattheinternaldiameteroftherubbersealis muchsmaller than that of the jacking pipe and is installed to prevent the slurry or ground water from escaping the tunneling machine when it emerges at the receiving shaft. The exit seal shall be capable of withstanding anticipated pressure of the pressurized slurry with bentonite and/or the hydrostatic pressure.

GuideRails(orJackingTableorFrame)

Tofacilitateplacingofthemicrotunnellingmachineandpipesinthejackingshaft,aseto f guiderails areinstalled inposition onthe base oftheshaft.The guiderail assembly(also known asjackingtable/ frame) shall be carefully set up in the shaft to correct alignment and gradient so that the pipe when placed on it stays in line with and square to the pipeline alignment. The guide rail assembly shall be independent of the thrust wall so that it is not disturbed due to jacking force exerted onto the thrust wall.

ThrustPressure Plate

The thrust pressure plate is usually a 50mm or 100mm thick steel plate installed between the jacks assemblyandthethrustwall.Thepressureplateenablestheconcentratedjackingloa dfromthejacks to be transmitted evenly to the thrust wall.

IntermediateJackingStation

For longer distance jacking, intermediate jacking stations, comprising a telescopic type jacking pipe assembly (usually made of steel), are used. A set of inter jacks and push ring are installed around the innersideofthefemalepipeofthetelescopicpipeassembly.Theintermediatejackingpipeassembly shallbeinstalledatappropriatepointandjacked-inalongwiththeotherjackingpipes.Thecontractor must plan for number of intermediate jacks as necessary for successful completion of the drive without overstressing the jacking pipes.

Cutterhead(Microtunneling)

It is usuallya disc shapedwheel mountedon the faceof the microtunnelingmachine(shield)andis driven by hydraulic or electrical motor, located within the machine. The excavation capabilities of a microtunnelingmachinedependsverymuchonthetypeofcutterheadused,itsspeedofrotationand averageand peak torque etc.

Differenttypesofcutterheadconfigurationareusedinmicrotunnelingmachinestosuitthetypeand nature of the ground through which tunneling is to be carried out. For example in soft ground tunnelingthe cutter head shall have bits arranged in such a way to cleave and guide the soil into a chamber behind the cutter head through the openingsprovided in the cutter wheel.

Inthecaseofrockorhardgroundtunnelingthecutterheadshallbeequippedwithsuitablebits,roller bits or disc cutters for effective transfer of cutting energy to rock. In case of clay/ sand or mixed ground conditions, the cutter head shall be designed to suit the geotechnical conditions involving the site.

Cutterhead(Auger boring)

Incaseofaugerboringinrockystrata,theequipmentshallbefittedwithappropriatetoolslike“Front Steer” or “Pilot Tube System- RVS” or active and passive hole openers as necessary for successfully drilling in the anticipated ground.

JackingRing

Jacking ring or thrust plate is a purpose made structural fitting which shall be installed between the jackingassemblyandthejackingpipetotransferthepointloadsfromthe individualjacksintoevenly distributed jacking force to the pipes being jacked. The ring shall be fabricated and machined, if necessary, so that it fits exactly onto end of the jacking pipe.

PerformanceRequirements

Design Life

For the purpose of designing the pipelines and the associated structures, the design life shall not be lessthan60years.Thematerialsincorporatedintheworksandtheworkmanshipshall beofrequired quality to sustain the specified life span.

LevelandAlignment Accuracy

Thepipesshall beinstalledintoplace,truetolineandlevel.Themaximumtoleranceallowableinthe displacement of the center line of the laid pipe from the design center line is 50 mm in the horizontal plane and 25mm in the vertical plane but there shall be no back-fall at any point.

There shall be provision to prevent the relative movement between pipes at the joints by the use of steel gaiters or other approved methods during jacking operation. A packing piece of compressible materialshallbeprovidedateachjointandshallbesecurelyheldbeforethepipesarelo weredintothe thrust pit.Details of proposals shall be submitted to the Engineer for approval.

TheContractorshallberesponsibleforensuringaccuracyofpipelayingbymicrotunnel lingandshall take due cognizance of the ground conditions.

Limitsongroundsettlementandupheaval

The trenchless technology method adopted by the Contractor shall be such that the initial surface settlement measured directly above the front face of the shield or boring equipment during the tunneling/ boring/ pipe jacking operations does not exceed 15mm and the maximum surface settlement after the tail voids are grouted shall not exceed 25mm. The affected ground and the structuresshallbesubsequentlyreinstatedtotheiroriginalconditionatContractor’s riskandcost.

For the sections of pipeline crossing under nallas, roads and railways the Contractor shall be required to incorporate in his tunneling method measures to arrest the expected settlements so as to safeguard theintegrityoftheroadsurfacesandcollapseofnallabed.TheContractorshallensuret hatthetraffic flow along the roads is not affected in any way as a consequence of his work.

In case of the works of laying sewers across any nallas or water courses, it may be necessary to provide kentledge to prevent upheaval or escape of slurry or to ensure proper overburden above the crownofthepipebeinglaidbymicrotunnelling.Thecontractorshallensurethatproper arrangements for non disruption of the flow through such nalla or water course are made by adopting appropriate measuresapprovedbytheEngineer.Suchkentledgeindrainsshall beremovedandwaterwaycleared aftercompletionofthework.Noextrapaymentshallbeadmissibleforprovisionandre movalofsuch kentledge.

Providingtemporaryaccesstothejackingorreceivingshafts

Thealignment/ placementofmanholesandshaftsmighthavetobetakenoutsidethecarriagewayin to kutcha portion.

Whereitisseenthatthelocationsofjackingandreceptionshaftsdonothavedirectacces sfromroads for taking construction plant equipment, the Contractor may have to provide temporary access including access over barges/ boats and also to erect marooned barges at the site of the reception shafts. Anytemporaryarrangement shallbe subsequentlyremoved, and the siteconditions restored to their original state upon completion of the work.

LimitationonFootprintandweightof machine

The Contractor shall be deemed to have visited the sites and carefullyplanned and located theshafts at convenient points so as to minimize the working area to be occupied by the footprint. The contractor shall be deemed to have allowed for such site constraints and measures required, including working in the night and construction of decking over the shafts, provision of access roads for construction plant and machinery, to allow the traffic to flow, in his rates. He shall take the site constraints and restrictions into consideration when selecting the trenchless technology system. It is necessary to pay close attention to the ground conditions, bearing capacity of the ground at appropriate level and select the head and equipment accordingly. The weight of the equipment selectedshouldbesuch astoeliminateequipmentsettlementduringdrivingthetunnelandinstallation the pipes.

Contractor’ssubmittals

Generalinformationonsubmittals

ToensurecompliancewiththerequirementsspecifiedintheContract,thecontractors hallmakea number of submittals as described in the following clauses to the Engineer for approval by the

specified time. The contractor shall ensure that the submittals prepared are of good professional standard,complywithalltherequirementsspecifiedinthecontract andcompletewithalldetailsand information to enable the Engineer to evaluate and approve the submission. It shall be clearly understood by the contractor that he shall not commence any work without the approval of the submittals by the Engineer.

Submittalsbythecontractorshall,include:

- Contractor’smethodofconstruction
- Microtunnellingequipmentdescriptionandliterature
- Jackingsystemandmaximumjackingloads
- Pipedesignsandshopdrawingsandcalculationdemonstratingtheabilitytosustain maximum jacking loads
- Intermediatejackingstationsdetails
- Lubricationsystem
- Bentoniteinjectionsystemdetails
- Groundwatercontrol details
- Entryandexit details
- Jackingandreceivingshaftdesign details
- Thrustblockdetails
- Muckremovaland disposal
- Buriedservicesdetails
- Detectionequipmentoranyothertrenchlesstechnologysystemequipmentetc.

AllsubmittalsshallbesubmittedbytheContractorinaccordancewithschedulementioned.

Submittal on Contractor’s method of construction- Microtunnelling including construction of shafts

The submittal shall contain a detailed explanation of various steps involved in the construction process. They shall include details of the equipment, specific manufacturer’s instructions and guidelinespertainingtotheproject,amethodologystatementoutliningtheoperationoftheequipment and, details of materials including pipe materials, rubber ring, and compressible packers and jointing of pipes.

The submittal shall also include construction details of other permanent and temporary structures such as jacking and receiving shafts, cast in-situ and precast manholes, or brick masonry manholes, thrust walls, and entry and exitof the shaft. The details of other equipment such as intermediate jackingstations,spoilremovalsystemincludingslurryandfeedpumps,controlsyste

ms,slurrytanks

andassociatedmachinery,jackingframes,spacers,thrustringetc.,shallalsobeinclud edinthe submittal.

Submittalongeotechnicalprofileandgeotechnicalreportsalongthepipelineroute

The Contractor shall establish the subsurface ground conditions and their range of variability along the pipeline before embarking on the works. He shall clearly identify the types of soil or rock that is likely to be encountered during boring or tunneling along the entire pipeline alignment. If found necessary,heshallcarryoutsimpleprobingtechniques. (GeophysicalsoundingsorSeismicrefraction method and soil resistivity tests)

Heshallprepareacomprehensivegeotechnicalprofilealongthepipelineroutewithdet ailed descriptions of the types of soil or rock to be expected during boring/ tunneling.

The Contractor shall endeavor to carry out essential geotechnical investigations and tests (Field as well as laboratory) immediately after award of the work for enabling him to select appropriate equipment/ methods. The Contractor shall be solely responsible for geotechnical investigations and the inference drawn from such investigations as well as the adequacy of the equipment and method adoptedbyhim.However,otherprogressofworkslikeconstructionofshaftsetc.mayb econtinued simultaneously.

Submittalonjackingpipedesignandcarrier pipes

The contractor’s attention is drawn to the requirement pertaining to the design, manufacture and handlingofthejackingpipes.Thejackingpipesshallbemanufacturedinaccordancewi thJSWASA2 or BS 5911 Part 120 or equivalent standard approved by the Engineer. At the same time the pipesshall meet the test requirements for NP4 pipes under IS 458.

The Contractor shall with the approval of the Engineer, engage a reputable pipe manufacturer to design and manufacture the jacking pipes. The submittal shall include the manufacturer’s name, address,contacttelephoneandfacsimilenumbersandthemanufacturer’squalityass urance/control and testing plan for the jacking pipe.

The manufacturer’s representative’s name shall be also included in the submittal. A dimensioned drawingofthejackingpipewithdesigncalculationsfromthemanufacturershallbealso submittedto the Engineer for approval.

Thesubmittalforjackingpipes shall include particularsof the pipe moulds,castingfacility, QA/ QC forpipes,anti-corrosiveprotectiontothepipe.Thesubmittalshall beaccompaniedwithaletterfrom theplantownergivingguaranteefordeliveryofthepipesinaccordancewiththesched uleofworkas planned by the contractors and as directed by the Engineer / Employer.

The Contractor shall furnish a Memorandum of Understanding between the RCC pipe manufacturer and the Contractor for supply of Jacking Pipes and also an undertaking from the pipe manufacturer thattheypossessavalidBISlicenseandhavesuppliedatleast500mofjackingpipesof1000mmand above which have been successfully installed by micro tunnelling anywhere in India.

In case MS jacking pipes are considered necessary as sleeve pipes as a requirement of contractor's methodologyformicrotunnelingandpipejacking,thesameshallbeatnoextracosttothe Employer.

TheMSsleevepipesinsuchcaseshallbeofappropriatesizetoaccommodatecarrierpipeofrequired ID and shall conform to IS 3589 and shall be coated with anticorrosive coating as per the IS code requirements.InsuchcasesRCCcarrierpipesconformingtoIS458orHDPEpipesconformingtoIS 14333 or IS 16098 Part 1 or 2 shall be installed inside the sleeve pipes.

Submittalonmicrotunnelling/pipejacking/augerboringsystem

The bidder / Contractor shall furnish name of the micro tunneling/ auger boring system, model, manufacturer's technical literature for the equipment and all other data along with their bid.Any amendments deemed necessary by the Contractors shall be submitted along with the geotechnical profile within 21 days of submission of geotechnical profile to the Engineer. The submittal shall include information to ensure that the micro tunneling/ auger boring equipment proposed for the project meet with the general requirements specified in these specifications and also the anticipated geological conditions. The submittal shall also include a certification from the manufacturer of the equipment about adequacy in the anticipated geotechnical conditions as also design calculations showingmaximumanticipatedjackingorpullbackforceandtorqueneededfortunneling/boring.The details shall also provide informationof rock cuttingtools or heads,spoil removal methods, guidance systems, jacking system and capacities, interjack systems, hole lubrication systems etc.

Submittalonsite layout

Contractor's attentionis drawn to variousclauses inthe document aboutthesiteconstraints andspace availabilityinallthesites.Thecontractorshallcarefullyexaminethesiteandpreparesitelayoutplans showing extent of work site, the arrangement of various ancillary equipment required for works, such as approaches for equipment, spoil removal

equipment and slurry tanks, bentonite systems/ mud recycling system, generators, control cabin, tracking facilities, crane, storage of pipes etc for each drive and submit them progressively to Engineer for approval.

Submittal on existing pipe network details, ground and invert levels, location of shaftsand new pipeline alignment

The contractor shall survey and verify the as-built invert levels of the upstream and downstream pipelines and manholes shown on the contract drawings for all the sites. The contractor shall confirm or insert the correct as-built levels in the contract drawings and submit them to the Engineer for necessaryamendmentsandreissueofthecontractdrawingsforconstruction.Undern ocircumstances the contractor shall commence works without verifying the as-built levels and obtaining the approval of the Engineer.

TheContractor will be requiredtosetoutand plantheactual placement ofthealignment forthe pipe layingwellinadvanceofactualexcavations.Trialholes/probingandotherpreliminary surveysmust be carried out and the resulting information carefully plotted.

For convenience of construction, if the Contractor prefers changes to the pipeline alignment or the locationofmanholes,heshallsubmitsuchchangestotheEngineerforpriorapproval.T heEngineer would evaluate and approve if the proposed changes are found to be economically and technically, and functionally acceptable. It shall be clearly understood by the Contractor that any construction risks and additional costs arising as a result of Contractor’s changes made to the original pipeline design shall be entirely borne by the Contractor.

Submittalonjackingandreceivingshaft design

The Contractor shall submit the design and construction details of the jacking and receiving shaft and theirproposedlocationsalongthepipelineroutetotheEngineerforapproval.TheCont ractor’sdesign shall ensure that the shaft dimensions are absolute minimum required and method of constructionshall be such that the shafts are constructed without causing unacceptable obstruction to the existing traffic flow in the vicinity of the construction. The minimum size of the shaft shall, however, permit construction of appropriate manhole / valve chambers as per the requirements. The Contractors shall also submit design and construction details of decking, if required, for the shaft. The Contractor shall be deemed to have allowed for in his Bid for such decking work necessary to maintain the trafficflow.

Thesubmittalshallalsoincludedetailsonshoringsystem,entryandexitarrangement,t hrustwall layout and design details, general layout of guide rail and jacking table arrangement etc.

In case the shafts are to be constructed by method of well sinking, the

contractor shall provide completedesigndetailsalongwithmethodofsinking,soilremoval,dewatering,concretesteining, kentledge arrangement etc. for approval of the engineer.

Incaseofshaftsintheformof RCC wells, branch connections to the manholes constructed inside the well shall be provided at no extra cost to the Employer.

Submittals for obtaining approval from authorities

The Contractor shall submit separate schedule for obtaining approval of various authorities and obtain specific permission or approval through the engineer.

Submittal on buried services and obstructions

The Contractors shall investigate and determine the actual location of the buried or over the ground services (Metallic and non metallic) and physical obstructions, if any, along the pipeline route and at his chosen locations of the jacking and receiving shafts, and submit service location drawings to the authorities responsible for electricity, telecom, water, pipeline, gas etc and obtain their approval or permission to excavate in their vicinity. The contractor shall use a good quality Ground Penetration Radar (GPR) for this purpose and shall submit complete details of the equipment and procedures for field investigations and laboratory/ desk analysis of the data captured in field.

The Contractor shall not interfere with the operation of any existing or proposed service. He shall carefully plan the pipeline route and the locations of the shafts and manholes and shall identify the services that require diversion well ahead so as to give ample time to the authorities to divert the services or give approval to carry out the diversion by others. Where applicable, the Engineer would assist the contractors in getting the approval as expeditiously as possible from authorities.

If in the opinion of the Engineer any services that are within the manhole proper or affecting the alignment and require permanent diversion, they shall be diverted at the expenses of the Corporation. Expenses for all other diversions and temporary protection of services shall be borne by the Contractor.

Any consequential delays or expenditure arising from Contractors' carelessness or lack of foresight on this matter shall be entirely borne by the Contractor.

The Contractor shall fully co-operate with the Engineer and the authorities and shall have no claim for delay due to such relocation of services.

TheContractorshallallowforsufficienttimeforgettingthepermissionsfromthe authorities.

Submittalonmonitoringof groundsettlementandupheaval

The Contractor shall monitor ground movement daily at the start of jacking operation and end of the jackingoperationonthatdayandsubmitinanapprovedformatthesettlementoruphea valcausedby the micro tunneling and pipe jacking works to the Engineer.

It shall be incumbent upon the contractor to measure ground movements along the route of pipeline laid for a width of at least 5m or 2 times the depth of the pipe being laid on either side of the center line using appropriate equipment such as seismographs, accelerometers during construction and measurethemat leastonceinsixmonthsduringthedefect liabilityperiodandincaseanysettlement of ground or pipeline is observed, the contractor shall take remedial measures at his risk and cost.

Thecontractorshallalsoconductajointsurveyofstructuresinvicinitytomonitoranycr acksorsigns of distress and take timely remedial measures at his risk and cost.

Submittalon Safety

The Contractor shall be solelyresponsible for safetyof the workmen, Engineer's staff and thirdparty. The contractor shall implement a comprehensive safety plan for his work people and Engineer's/ Employer's staff or Third party. He shall comply with all relevant acts governing safety on constructionsite.HeshallsubmittotheEngineerthedetailsofthearrangementshema dewiththefire brigade, local health authorities and the availability of medical staff, first aid equipment ambulance, sick bay etc. He shall give the names and contact telephone numbers (24 hours) of the occupational health and safetypersonnel.Beside heshall submit alist of safetyequipment thathe wouldprovideto all the workers on site. The Contractor shall appoint a Safety Officer or Safety Engineer at all times who shall be the responsible person for all safety related matters pertaining to the contract. Name of such person shall be communicated along with the submittals on safety. The contractor shall comply with the guidelines issued by any competent authority regarding safety at work site especially safetyof persons working inside any pipeline- new or functioning. This shall be consistent with the contractor's obligations under the GCC/ SCC.

Submittalonqualityassurance/controlplan

The Contractor shall implement a Quality Assurance Program approved by the

Engineer for the manufacture of jacking pipe and for actual installation of the pipes trenchless method on site. The QualityAssuranceProgrammeshallbemaintainedinaccordancewiththeprovisionofthemanual.
NoworksshallcommenceuntiltheQualityAssuranceManualhasbeenapprovedbythe Engineer.

TheContractor’sQualityAssuranceSystemshallincorporatebutnotbelimitedtothefollowing:

(i)The Quality Assurance and Quality Control procedures covering all materials, design, manufacture,supplyandinstallationcarriedoutbytheContractorandanyofhissub-contractorsand pipe manufacturers.

(ii) Suchtestsnecessarytodemonstratethatmaterialscomplywiththerequirementsofthis specification and the requirements of the relevant Standards and Codes.

(iii) Contemporaryrecordstobemaintainedpertainingtoprogressofthework.

TheQAPshallmentioncheckpointsandholdpointsandmustbescrupulouslyfollowed.

TheContractormustbeISO9001-2015certifiedorganizationandmustsubmittheQualityManual for implementation during execution of the works.

SubmittalonContractor’spersonnel

TheContractorshallappointa dedicatedProjectManageralongwithatleasttwodedicatedsite engineers experienced in micro tunneling work for this contract.

TheContractorshallnotethattheskillofMTBMoperatorandtheirassistantsiscrucialforsuccessful execution of work. The contractor shall submitcomplete informationfortheoperatorsproposedtobe employedforthework.AtleastoneMTBMoperatormusthaveanexperienceinoperatingMTBMin India.

TheContractorshallberequiredtodeploythekeystaffascommitteddduringthebiddingprocess.No changeinthepersonnel shall bepermittedsubsequentlywithout writtenapprovaloftheEngineer.He shall submit the diagram showing the communication link within the site to Contractor's Head Quarters alongwith designation and telephone numbers of key staff for the Engineer's record. The Engineer reserves his right to reject any person who he thinks not suitable for the contract and the Contractor shall be obliged to replace such person immediately.

Submittalonremedialmeasurestobeadoptedbythe Contractor

TheContractorshalltakeeachandeveryprecautiontoensurethatthetunnelingordrill

ingequipment will successfully excavate along the chosen pipeline alignment before he commences the operation. Once the tunneling/ drilling is commenced in a drive, the Contractor will be held fully and wholly responsible for thesuccessful completion of the tunnel excavation and retrieval ofthe shield from

the receiving shaft or for completion of pilot bore and hole enlargement upon back-reaming. In the event of inability to complete the drive, due to break down or any other reasons, the Contractor shall befullyresponsibletorecovertheequipmentsafelyfromthegroundandrestoretheincompletework totheoriginal conditionathisriskandcost byamethodapprovedbytheEngineer andtheconcerned authorities within time stipulated by the Engineer or the concerned authority.

It shall be clearly understood by the Contractor that the occurrence of such an event is preventable as suchanoccurrenceisgenerallyduetoContractor'snegligenceinthe"preventivemaintenance"ofthe equipment or driving of it to true level and gradientorhis failure to determine accurately the expected ground conditionsbefore commencement of the excavation.

The Contractor shall in his submittal clearly state the measures that he would implement to retrieve the shield without causing interruptions to railway, highway or road traffic etc., and without causing anydamagetotheproperty.Thecostforsuchretrievalmeasuresoranyconsequential expenditureor delays arising from thereof shall be entirely borne by the Contractor. Any failure to remedial measures shall be entirely at the risk and cost of the Contractor.

AnyabandonedholeortunnelmustbegroutedcompletelyattheContractor'scostsoastoprevent subsequent settlement.

Submissiononworkschedule

Notwithstanding the obligations of the contractor under the GCC, the contractor shall submit a detailedworkschedulewithsuitablemilestoneevents.Theworkscheduleshallalsotakecognizance ofthemonsoonseason,waterlevelsandtheirfluctuationsinthereservoirandtheirimpactonability to carry out the work etc.

Abaselinescheduleshallbesubmittedalongwiththe bidwhichshallbefrozenwithin15daysof award of the work to successful bidder.

EffectofApprovalandAcceptanceofProposals

ApprovaloracceptancebytheEngineerofanyproposalforexecutingtheWorks,including drawings, specifications or resources employed under the Contract shall not

relieve the Contractor of his responsibility for any errors thereon and shall not be regarded as an assumption of risk or liability by the Corporation. The Contractor shall have no claim under the Contract on account of the failure or partial failure or inefficiency of any plan, method of work or equipment approved or accepted by the Engineer. Such approval or acceptance shall be considered to mean only that the Engineer had no objection to these proposals.

Notwithstandinganyapprovaloracceptancebytheengineer,theContractorshallremainfully responsible for completing the Works correct in every detail.

Scheduleof submittals

Belowisageneralscheduleofsubmittalspertainingtotrenchlessworksbythe contractors

Sr. No	Description	Scheduleof submission
1	Contractor's methodof construction.	Alongwiththebid.
2.	Geotechnicalprofilealong pipeline route.	Within30daysofdateofcommencementletter.
3.	Jackingpipedesign	Alongwiththe bid.
4.	Microtunnelingsystem.	Original submission along with the bid and any changes necessitated by the geotech investigation shall be submittedwithin15daysofsubmissionofgeotech profile.
5.	Sitelayout	Within45daysofcommencement dates.
6.	Proposed Intaek Location andshaftsandnewpipeline alignment.	Within45daysofcommencement dates.
7.	Jacking&Receivingshaft design.	Along with the bid.Any changes necessitated by the geotechinvestigationshallbesubmittedwithin15daysof submission of geotech profile.
8.	Approvalfromauthorities.	Within90daysofcommencementdate
9.	Obstructions.	Within45daysofcommencement letter
10.	MonitoringofGround settlement&up level.	Alongwiththebid.
11.	Safety.	Alongwiththebid.

12.	Qualityassurance/ Central plan.	Alongwiththebid.
13.	ContractorsPersonnel	Alongwiththebid.
14.	Remedialmeasures.	Alongwiththebid.
15	Work schedule	Alongwiththebid

Products

StandardsandCodes

ExceptasotherwisestipulatedinthisSpecification,allmaterialsandworkmanshipshallcomplyinall respects with requirements of such standard and specifications, codes and other standards issued by theBureauofIndianStandards(BIS)andcurrent at thedateofbidasmaybeapplicabletoanypart of the Works of this Contract. In the event there being no relevant Indian Standard Specification, other relevant standard,specification,current atthe dateof biddingsuch asthe British StandardsInstitution (BS), American Society for Testing Materials (ASTM), German Standards (DIN), Japanese Standard for Water and Sewerage (JSWAS), and/ or of the or any other equivalent standard approved by the Engineer shall apply. If after the date of invitation to Bid there is an amendment to a standard specification relevant to the Contract, the Engineer will direct whether the amendment is to apply.

In the event of there being any conflict between this Specification, the Drawings and any Standard SpecificationformingpartofthisContract,thisSpecificationshalltakeprecedenceoverthedrawing, codes and other standards in that order of precedence. In any case, the Engineer’s decision shall be final and binding on the Contractor.

Selectionof Equipment

The contractors shall be responsible for the selection of a suitable micro tunnel boring machine capableofexcavatingthematerialsincludingsoftmarineclaywithhighwatertable,rocksandmixed ground that may be encountered along the route of the pipeline to be laid under the contract.

TheContractorshallbesolelyresponsibleforensuringthatgeologicalandgeotechnical information heobtainsorpossessesforthesitesisadequatetoaccuratelydeterminethetypesofsoil that maybe encountered duringexecution of the project.The contractor is deemed to have carried out sufficient geological and geotechnical investigation of the sites and testing of the soil as necessary at his own cost before the selection of the micro tunneling system.

Contractorshallberesponsibleforselectingsuitableequipmentfortrenchlessinstallationofthe sewers capable of excavatingall soil types which may be countered duringthe execution of the project.

Thecontractorshallalsoensurethatthesystemheselectsfortheprojectshallsuccessfullyexcavate in the wide rangingground conditionsfromclayeyandsandystrata tomixed ground/ hard rockthat may be encountered along the route.

Contractors shall pay particular attention, when selecting the tunneling/ boring equipment for the project, to ground water level fluctuation and the wide ranging subsurface soil strata from marine clays,sands,gravels,softsoilsthatmaybepresentatthesites.Theequipmentselectedfortheproject shall have appropriate cutter head equipped with suitable cutter bits to excavate all types of soil formations below the water table.

Thetunneling/ boringequipmentshallbecapableofbalancingthegroundwaterpressuresupporting the excavated tunnel face at all times. The equipment shall be articulated to enable remotely controlled steering, in both the horizontal and vertical directions. It shall be capable of preventing rotation and rolling movement of shield’s body during the drive.The tunneling/ boring equipment shall, have the following features.

(a) Equippedwithsuitablesteeringandguidancesystemthatensureseasysteering control(With arrangement for anti roll, or pitching/ dipping)

(b) Equippedwithasuitablelubricatingsystemarrangement

(c) AbilitytoprovideforanIntermediateJackingStation,asneeded

(d) Instrumentationtomeasuredeviationfromthedesignedlevelandgrade,rolling andpitching of the equipment, cutter torque and itspercentage to the maximum torque, rpm, jacking speed, tunnel face pressure etc. preferably with a computerized data logging and printing facility.

(e) Spoilremovalsystem(Slurry/ Augersystem)capableofremovalofexcavatedstuffby balancing the face pressure.

(f) Themachinehallbemanufacturedbyareputedmanufacturerhavingsupplied atleastone such machines during last five years in India and the supplied machines must have successfully carried out underground pipe installation work for a length of at least 500m.

Theequipmentproposedfortheprojectshallmeettheabovementionedcriteriafailing whichitwill not be permitted to be used in the project.

JackingPipes(RCC/MS)

The pipes must be manufactured in a reputed pipe manufacturing facility using vertical vibration castingmethodhavingvalidBISlicenseformanufacturingofRCCpipesfrom450mmto 1400mm (NP3/ NP4 Class) under IS 458.

Pipesmanufacturedbythecontractor'sthemselvesinatemporarymanufacturingfacilityshallnotbe acceptable.

Thepipesforjackingoperationshallbeprecastreinforcedconcretepipesmanufactured byvertical vibration casting process only.

Design, manufacture and factory testing of the pipes and specials shall be to BS 5911 Part 120 or JSWAS A-2-1973 orother acceptable standard and shall meet the test requirement specified in I.S 458(NP4Class)oritsequivalentstandardasamendedupto-date.Thegradeofconcreteshallnotbe less than M45 design mix. The clear cover of concrete over steel reinforcement on the wet side shall not be less than 25mm.

ThejackingpipesshallbeprovidedwithStainless SteelCollarsfixedtothefemaleendofthejacking pipe.

Each pipe shall be providedwith aprecision cut compressiblepackerto be attached to pipeend with approvedadhesive.TheContractorshallalsoprovidedetailsofthecompressiblepackerincludingits dimensions, Modulus of elasticity etc.

The outside and inside diameters of the pipe shall be such that they match the dimensions of the tunnelingequipment or vice versa.The standardlength of the pipe shall be 2.5m(Between 2.43mto 3.05m).However,thelengthofthepipeshallbeshortenedifdesiredbythecontractortosuitthesite conditions subject to the Engineer's approval.

The concrete used for jacking pipes shall be from a RMC plant. If the concrete for manufacturing pipesisproducedattheplantitself,itshallbemanufacturedinanapprovedautomaticbatchingplant. Complete details of the Batch of ready mix concrete like its Grade, WC ratio, maximum aggregate size, time of leaving the RMC plant, time of pouring into the moulds, additives and suppliers certificate shall be maintained for each batch. Three cube samples shall be taken from each RMC batch and tested for 28 days strength in a laboratory approved by the Engineer. If the test cubes fail the requirement, the finished pipe shall be liable

for outright rejection after NDT (Schmidt Hammer Test or any other as directed by the Engineer).

TheEngineer’srepresentativeshallhavefullauthoritytoinspectanymaterialorfinished productand reject the same if not found conforming to the standards. The Contractors shall make his representative available to the Engineer’s representative during such inspections and testing failing which the Engineers representative shall be at liberty to take ex-parte decision, which shall become binding upon the Contractor.

The pre-cast reinforced concrete pipes shall be sufficiently reinforced with steel to withstand all stressesinducedbyhandling,jacking,earthandwaterpressuresandallworkingloads atthedepthsat which they are to be used without cracking, spalling or distortion.The pipes shall be of at least strength Class NP4.Aload factor (for the maximumjacking force) of not less than 2.0 shall be used in the calculations to determine the strength of the pipes required.The strength of the pipes shall be tested by the three-edge bearing test.When subjected to the design load in such a test, the load required to produce the crack width of 0.25mm on the pipe shall be in accordance with IS Code 458. All such tests shall be carried out at the expense of the Contractor. The frequency of the Three Edge Bearing test shall be at least once in 3 months or every 100 pipes or part thereof for each diameter.

Whendesigningthejackingpipes,thecontractorshalltakeintoconsiderationjacking loadincluding eccentric loading, pipe stiffness, corrosion resistance, flexibility, durability, joint efficiency etc.

TheContractorshalltakeprecautionstominimizetheresultantpipestressesinajacking pipeandto achieve a trouble free jacking operation. The eccentric loading shall account for maximum steer ability.

The Contractor shall submit full details of his proposals for the pipes, giving detailed drawings showing sizes, reinforcement and type of joints, calculations, together with the name of the proposed manufacturer, the place of manufacture and the manufacturing process to the Engineer for approval alongwithaconsentletterfrommanufacturerofthepipesfromsuchmanufactureaswellastheRMC supplier.

A detailed record (signed jointlybythe Contractor’sand Engineer’s Representative) ofconcrete batch,its7dayand28daystrength,weightofreinforcementcage,weightanddimensionsofthe collar etc. shall be maintained for every pipe manufactured for use in the works.

Every pipe tested for the three Edge Bearing Strength shall also be tested for

ultimate (crushing) test inpresenceoftherepresentativeoftheEmployerorPMCand/orThirdPartyInspection Agency.The pipe to be tested for three edge bearing test shall be randomly selected by the Engineer or any designated agency. At least one pipe in 200 pipes for each diameter must be tested for three edge bearing test outside the manufacturer’s factory in a test facility as directed by the Employer. The test set up and the gauges shall be properly calibrated with a certificate from an agency authorized to do

thecalibrationofequipment.ThepipesshallmeettherequirementsoftheStandardsfo rJackingpipes likeJSWAS/ BS oranyother acceptablestandard but the requirements of strength and othertests like hydraulic and permeability shall be in accordance with IS 458.

All workmanship and materials used in the manufacture shall be subject to the approval of the Engineerwhoshallbeauthorizedtoinspectmaterialsatsourceandthemanufacturin gprocessesin the factory at any time.

Propercuringarrangementintheformofwaterspraycuring,steamcuringorchemical curingas approved by the Engineer shall be provided.

(a) Pipeshallbestraightanduniformwithsquareends.Thejointsshallbewellform edtoallow efficient transfer of jacking load from pipe to pipe

(b) Pipejointshallbefittedwithcompressiblepackerforbetterdistributionofjackingload.

(c) The jacking frame, jacks and steering head shall be properly aligned along the designed alignmentandgradeandthewholeassemblyshallbesquareandatrightangle stothethrust wall

Steeringcorrectionsshallbemadegraduallytominimizeabruptmisalignment anglesbetween the pipes

Thepipesshouldbeprovidedwithwell-formedarrangementforgrooveforrubbergasket.

Thepipesshallbeinternallylinedwith“T”ribtypeHDPEsheetliningascorrosionbarrie r(2to3mm thick) installed while casting of the concrete pipe.

Thepipesshallbesufficientlycured(Minimum28daysifwetcuredwithwatersprayora sapproved bythe Engineer is cured with steamor byapplication of chemicals) beforetheyaredispatchedto the works sites and used in the jacking process.They shall be handled with extreme care to prevent the edges of the pipes from chipping.The pipes shall be stacked in shade or adequately protected from severe sunrays. The Engineer may reject any pipes he considers not suitable for the Works and these rejected pipes shallberemoved fromthe siteimmediately.After factorytestingand beforedispatch, every pipe and special shall be marked in accordancewith the Standard used.In addition, each pipe shallbemarkedwithanumbercorrespondingwiththeorderofmanufactureanddateof manufacture and Grade of Concrete. Test certificates from the manufacturers or other relevant authority shall be submitted to the Engineer.

Thepipemanufacturingandtestingprocessshallalsobesubjecttothird Party Inspection.Pipesshall not leave the manufacturer's facility unless they are released by the TP agency/ PMC/ the Employer.

Thesitesmayhavelimitedorrestrictedstoragespaceforstackingofjackingpipes.The Contractor shall therefore schedule the supply of pipes to the sites in such a way that only absolute minimum numbers of pipes are brought to the site at a time.

IncaseofMSjackingpipes,thepipesshallbemanufacturedandtestedincompliancewithIS3589 and shall be provided with liquid epoxy coating/ lining system as per ANNEX B of IS 3589.

CarrierpipesshallcomplywiththerelevantIS Standards.

PipeJoints(RCCandMS)

The jointing arrangement for the jacking pipes is crucial in terms water-tightness, flexibility and smoothtransmissionofjackingforce.Spigotendedjackingpipewithrecesstoreceive rubberrings and stainless steel/ Mild Steel couplings (collars) or other acceptable joints shall be used in pipe- jackingapplication.Thespigot andsocketjointsshall beflushfromoutsideaswell.Thecontractor shall submit joint details to the Engineer for approval.

The joint rubber rings supplied and installed shall be of the Cornelius rubber ring type or similar approved and shall be capable of accommodating 2 degree deflection at each joint. Joint rings shall meet withthelatest editionofI.S5328andB.S2494part2orbeofapprovedqualitybytheEngineer. The properties of the joint ring shall be between those specified in BS 2494 for grade D and grade B.

ThetestingofrubberringshallconformtoIS.3400andalsoIS.5382.

The Contractor shall indicate the grade of rubber rings he intends to use and submit samples for approvalpriortoincorporationintheWorks.Thegrade,typeorsourceofsupplyofrubberringsshall not be changed without the written approval of the Engineer.

MSpipesshallbewithweldedjointsasperIS5822

PipeCouplings(CollarsforRCCjacking pipes)

The pipes shall be provided with **Stainless Steel (SS 304 Grade) Collars.** The arrangement shall be ofsuchdimensionandthicknesssothatwheninsertedintothepipe,itfitsexactlyintotherecessesin the pipe.Thejoint soformed shall be watertight.Thejointdetailsshall be approved bythe Engineer. The thickness of collar shall not be less than 8mm.

Compressiblepackers

Appropriatecompressiblepackersshallbeusedatthejointsfordistributingthejacking forceevenly through the wall of the jacking pipes. Uneven transfer of jacking force from a pipe to another shall result in concentrated and excessivestresses in the pipe which can cause the pipe to crack. Contractorshallsubmitdetailsofthecompressiblepackersfor Engineersapproval.

Identificationofpipes,rubberringsetc.,

Everypipemadeshallbeclearlyandindeliblymarkeduponituniqueidentificationnumber,class, batch of concrete, diameter and date of manufacture.(Suggested format: FACT_NAME /DDMMYYYY/Mxx/BATCH_NO/ NNN) Every finished pipe shall be tested for dimensional conformityandnon-destructivetestingwithSchmidtHammeroranyothermethodasapprovedbythe Engineer. Full records are to be maintained of each pipe test and for each individual pipe the date manufactured, cleared after testing and supplied on site.

TheContractorshallmake arrangementsforvisitsoftheEngineer’srepresentativesforinspectionand 3 EB testing as and when deemed necessary by the Engineer. All expenses in connection with such visits shall be borne by the Contractors. After the satisfactory completion of testing and approval of the pipes by the Engineer the pipes shall be stored at factory premises during the period awaiting delivery.

No pipe shall leave the manufacturer’s yard for the site unless it is tested and cleared by the Engineer’srepresentativeandtheThirdPartyInspectionagencyappointedbytheEngineer/PMC.

Testson Jacking Pipes

FactoryTests

One pipe out of every 100 pipes or part thereof manufactured for each diameter shall be tested for Three Edge Bearing Test in the factory or a laboratory or institution approved by the Engineer at the Contractor’s expense. Besides this at least one pipe in every 200 pipes shall be tested outside the factory in a facility as directed by the Engineer. The pipe for testing at a test facility outside the manufacturer’s factory shall be selected at random from the pipes delivered

at site. All expenses in connectionwithtransportationtoandfro,loading/unloading,anttaxes/feesetcshallbebornebythe contractor.

EveryRCCjackingpipeshallbesubjectedtofollowingdimensionalconformitytestsan dthe tolerance shall be within limits as indicated below -

1. **Length**

PipeDiainmm	Toleranceforalltypesofpipesinm m
Above1200	+25

2. **Perpendicularityoffaces**

PipeDiainmm	RCJacking pipe
Above1200	8

3. **Deviationfrom straight**

PipeDiainmm	Toleranceforalltypesofpipesinm m
Above1000	±10

4. **Deviationfrompiped**

PipeDiainmm	Toleranceforalltypesofpipesinm m
Above1000	+0,-16

Execution

Informationfortheexecutionofworks

Theworksunderthescopeoftrenchlesstechnologyshallhavetobecarriedoutusingap proved trenchless technique.

The Contractor shall be responsible for inspecting the sites and familiarizing himself with the conditions under which the work will be performed and with all necessary details including geotechnicalconditionsandburiedservicesaswellasthephysicalconditions,tidalimpactsetc.asto the orderly and successful execution of the work.The omission of any details shall not relieve the Contractor of full responsibility for the satisfactory installation of the work in its entirety.No monetary or other claims made by the Contractor on the grounds of want of knowledge will be entertained by the Engineer.

Plansand details of the equipment, materials andthe methodof constructionto performand complete the work shall be submitted by the Contractor for approval of the Engineer before commencing these operations.ApprovalbytheEngineershallnotrelievetheContractorofhissoleresponsibilityforthe efficiency,reliability,andsoundnessofthemethodemployedincompletingtheworkin asatisfactory manner.

The Contractor is advised that it shall be his sole responsibility to ascertain for himself the extent of work that is required to be done in site and to generally obtain his own information on all matters affectingtheexecutionofthewholeoftheworksinvolvedinthiscontracttotheentiresatisfactionof the Engineer. No claim of extras in consequence of any alleged ignorance in any aspect will be entertained by the Engineer. It must be clearly and definitely understood that the contractor shall be held solely responsible for making all necessary arrangements and coordinating with all relevant Authorities, Specialists, Sub Contractors, etc., to ensure satisfactory and timely completion of this contract.

Executionofworks-General

TheContractorshallbefullyresponsibleforthedesignandconstructionofthejacking/launchingand receiving pits, thrust wall, installation of jacking equipment, installation of any other equipment, sheeting/ shoring, bracing, etc., and for the efficient execution of the work.

The Contractor shall be required to monitor closely the progress of the trenchless operations.Daily manual logs or site records of thrusting pressures, torque, bentonite injection rate and the line and level measurements shall be properly maintained in addition to any computerized data logging and shall be available to the Engineer’s representative at all times. Such records shall be duly signed by theContractor’ssitein-charge.IftheContractorfailstomaintainandproducesuchdetailsbeforethe Engineer’s representative on site, the Engineer’s representative may order

suitable steps including suspensionoftheworkwithout prejudicetoanyotherrightsoftheEngineer.TheContractorshall be solely responsible for such actions ordered by the Engineer’s representative.

It is the responsibility of the Contractor to ensure that the completed pipelines are watertight.If leakageoccursbeforecompletionorduringthemaintenanceperiod,theContractorshallcarryoutany remedial work that may be necessary to make the Works watertight all at his own expense.

Locationandverificationofburiedservices

The Contractor will be held solely responsible for making his own investigations of any buried servicesinthevicinityoftheWorksandtoprotectthemfromgettingdamagedduetohis work. Contractor shall be deemed to have allowed for any extra costs in his rates for detecting all obstructions and buried services including appropriate measures to protect the servicesand temporarily divert the same in consultation with the concerned agency with its prior approval regardless of whether they are indicated on the drawings or not. It shall be the Contractor's responsibilityto obtain anypermission fromsuch agencies.The Engineer/ Employer mayissue necessary recommendation letters to the concerned utility agencies if required.

Thecontractorshallengageathisowncostacompetentservicedetectingprofessional oragencywho shall have state-of -the -artdetecting equipment to locate and verify all the buried services such as pipeline, water,telecom, electricity, gas and all other services, andabandonedservices andstructures well ahead of commencing theworks.

The detector shall be able to receive narrow signal responses from metallic or non-metallic buried servicesinordertopinpointthepositionanddirectionoftheservices.Itshallalsobeable topickup the position and direction of different services in congested area and detect the buried services regardless of almost any environmental interference.

Combinationof Ground ProbingRadar (GPR) and Electromagnetic Location (EML) testingshall be used for locating the underground utilities and buried objects. The lines tested using GPR and anomalieslocatedusingEMLshallbetopographicallysurveyedusingaTotalStation/ Theodoliteat the same time as the geophysical testing is carried out.

The information so collected shall be submitted to the Engineer after getting it confirmed fromthe respectiveagency.ItshallbeclearlyunderstoodbytheContractorthatnoworkshallbe carriedout withoutlocatingalltheburiedservicesandhewillbeheldsolelyresponsibleforanycons equential expenses and delays if he ignores this specific requirement or fails to locate any services along the route.

The Contractor shall take every precaution that in the opinion of the Engineer

and as advised by the owner of the utility is necessary for the protection from injury of all existing and proposed water, drain, pipeline and other pipes, electric and telephone conduits, and other existing works, roads and services wherever encountered or which are adjacent tothe works, and to maintainthe same until in the opinion of the Engineerthe general progress of theworkrenders further protectionunnecessary.
AlldamageoccasionedbytheContractortotheseworksandservicesshallberepaireda tonceatthe

Contractor’sriskandcost,asdirectedbyandtothesatisfactionoftheEngineer.

Siteinvestigation

The Contractor’s site investigation for trenchless works in general shall be critical and the most important engineering work to be carried out before commencement of work on site. The contractor shall clearly understand the importance of establishing the subsurface ground conditions and their rangeofvariabilityalongthepipelineroutewellbeforeembarkingontheactualworks. Thereshould not beanyroomforunforeseengroundconditionsanditisabsolutelynecessaryfortheContractorto know what is to be encountered during the tunneling operation. The contractor shall be deemed to have accurately established the types of soil and rock strata along the tunnel bore and their range to enable him to select the equipment / machines and to set-up and operate correctly.

Subsurfaceinvestigation

The subsurface investigation shallincludes study of all existing geological andgeotechnical informationfortheareaincludingtheinformationpertainingtotheprojectandthelocationmapsof all the services in the area from the utility companies/authorities for initial planning. Data on abandoned and existing obstruction, foundation, piles and the structures in the vicinity of the alignment shall be also collected. Field survey using utility services locator and trial trenches mayalso be carried out to verify the location of the services and obstructions.

Mapping out of the subsurface soils/rock profile along the pipeline alignment and locating underground utilities and buried objects by geophysical testing. Investigations may include documentary survey; bore logs, geophysical investigations, in situ & laboratory soil / rock tests. Various geophysical investigations include but not limited to Ground Probe Radar (reflection of electromagnetic waves), Radio Magnetotellurgy (measurement of resistivity in electromagnetic field of a radio transmitter), Electrical Method (measurement of apparent resistivity by injection of direct currentandmeasurementofpotential difference),SeismicRefraction(refractionofseismicwaveson layersatspeedincreasingwithdepth),SeismicReflection(reflectionofseismicwaves oncontrasting interfaces), Microgravimetry. (local variation in gravitational field to detect cavities)

TheContractorisdeemedtohaveallowedforanyextracostsinhisratesandtobeaware ofsimilar state of the art ground probing/mappingtechnology currently available on the market and to have made provision for its use in the project as part of his subsurface investigation works.

Thecontractorshallbedeemedtohaveinpossessionofalltheinformationanddatarequiredto accurately evaluate the subsurface conditions before commencement of any works.

Geologicalandgeotechnicalevaluation

TheContractorisdeemedtohaveobtained,studiedandevaluatedallthegeologicaland geotechnical data for the sites including any data if available with the corporation for the sites and made his own judgment and conclusionon the types of soils and rockto be excavated alongthe pipeline route.The Contractor must supplement this information possessed by him with appropriate geotechnical investigationpriortoselectionofappropriatemicrotunnelling/ drillingmachineryuponawardofthe work.

The applicant shall inform him thoroughly and make his own deductions as to the nature of the materialstobeexcavated;thedifficultiesofmakingandmaintainingtherequiredexcav ationsandof doing other work affected by the geology of the Site and shall accept full responsibility thereof.

The Contractor shall carry out exploratory boreholes as deemed necessary by him and conduct laboratorytestingasnecessaryforamicrotunnellingproject.Thisinformationshallb esupplemented with tests such as soil resistivity tests and seismic refraction test to provide complete information about the stratigraphy in connection with the proposed works.

Itshallbeobligatoryforthecontractortoprepareageotechnicalprofilealongthealign mentshowing the proposed sewerline superimposedthereontoindicate strataanticipated.The contractor shall also detect and plot the buried services on the topographic survey map indicating their position in plan as well as approximate depth below GL.

However,thisdoesnotabsolvethecontractorfromhisresponsibilitiesforsuccessfulc ompletionof the work.

Borelogsandground probing

Sufficient numbers of boreholes shall be taken by the Contractor. The Contractor should submit Geotechnicalprofilealongtherouteofthepipelineandburiedservicesdatafortheenti realignment per the schedule for submittals.

Continuoussamplingshallberesortedtooveratleast2xDiaabovethecrownofthepipe and2xDia below invert of the pipe to be laid.

TheContractorshallcollectsoil/ rocksamplesatthelevelofthepropose dpipelineinpresenceofthe Engineer’s represent and get the same tested for sieve analysis, cohesion, angle of internal friction, ground water level,Unconfined Compressive Strength (UCS), abrasivityetc. at any laboratory

approvedbytheEngineer.SamplestakeninabsenceoftheEngineer’srepresentativea ndtestedina laboratory not approved by the Engineer shall not be valid for determination of the any parameters.

Groundwaterinvestigation

Ground water condition is one of the critical data required when selecting the trenchless technology system.Groundwateraffectsthesafetyoftheexcavationface,startandexitsofthetunn eling/drilling equipment from the shafts. Uncontrolled extraction of water from the surrounding during excavation can affect the adjacent structures. Piezo-metric pressure, water leakage, ground water level and etc., shall be carefully checked before and during microtunnelling/ drilling/ boring works.

Groundstabilization/improvement

It shall be the responsibilityof the Contractor to maintain stable soil conditions at the jackingface to prevent loss of ground above the jacking operation and movement of the surrounding earth or to prevent diving of the machine and sinking of pipes.The methods of maintaining face stability and preventing ground movement and subsidence shall be by means of fluid slurry or earth pressure appliedtothetunnelface.Alternatively,unstablegroundaheadofthejackingfacemay bestabilized by the injection of suitable chemicals.Methods which require dewatering of the ground will not be accepted, nor will methods which may lead to significant ground loss.

Movementorsettlementofstructures,utilitiesandpavementshallbemonitoredbythe Contractor during the trenchless operation and reported to the Engineer and concerned authorities.

TheContractorshallmake provisiontoinstallpeizometers,settlementplateetc.,inhisratesforpipe installation if movement or settlement occurs, which in the opinion of the Engineers may cause damage, the Contractor shall take immediate action to prevent further movement, settlement or damage.The Contractor shall repair at his risk and cost any damage and restore structures, and pavements to the satisfaction of the Engineer. The contractor shall pay expenses if the owner or concerned agency or any Third Party elects to carry out such repairs by themselves.

Settingout

The Contractor shall be deemed to have thoroughly examined the sites, the location of the buried services, availability of space for footprint, access to sites & etc., and adjusted the pipeline alignment as deemed necessary and obtained approval of the final pipeline alignment from the Engineer before

commencementofthesettingout.He shallsetoutandmarkonthegroundtheproposedpipelineroute and the locations of the jacking and receiving shaft and the area they occupy for the Engineer’s inspection and approval.

The Contractor shall be solely responsible for the accuracy of the setting out and any expenses or delaysarisingfromerrorsmadeinthesettingoutshallbebornebytheContractor.Anyconsequential

workorabortiveworkcarriedoutbytheContractortorectifytheerrorsshall beentirelybornebythe Contractor.

Sitelayout

Theworkingspaceatthesitesisoftenrestrictedandhencethesitelayouthastobeplan nedcarefully in advance to set-up the equipment and accessories.

ConstructionofJackingandReceivingShaft

The excavations for Jacking or Receiving shafts may be used for construction of manholes inside themprovided proper branch connections as directed bythe Engineer are cut inthe wells sunkfor shaft. The Contractor shall submit to the Engineer for approval dimensioned drawings and calculations of the timbering or trench sheeting details for the shafts.Eachshaft shall have a separate ladder bay for access which shall be isolated from the part of the shaft used for hoisting materials.Theshafttrenchingshallbewatertightandshallpreventanypressurizeds lurryfromthe tunnel face reaching the shaft.

Soilimprovement methodsthatcanbeusedincludegrouting,groundfreezing,anddewatering.Ifthe ground consists of unstable soil, the same may be stabilized by vibro / dynamic compaction, by compressedairforsandysoilsandbygroundfreezing,preloading,limetreatmentforcl ayeysoils.In certain instances, ground treatment or groundwater management methods may be required to enable theconstructionoftheshafttoproceed.Theseincludewellpointinganddeepwells,Co mpressedair, Suspension grouts, Chemical stabilization, Ground freezing.

There are various shaft construction method alternatives, Liner plates, 2-flange steel liner, horizontal metal sheeting, sloping or battered excavation, trench boxes, slide railing system, soldier piles with timber lagging, soldier piles with steel lagging, steel / concrete / RCC sheet piles, CMP shafts, concrete sinking shafts, precast concrete segments,concrete slurry walls, Pre-cast or cast in- situ caissons,Rockanchoragerodsandtensionedrockbolts,metalstraps,un-tensionedsteeldowels,Wire mesh with guniting and ground freezing. No extra payment shall be claimed by the contractors for carrying out soil improvement / stabilization, or shaft shoring techniques as mentioned.

The Contractor shall submit the design and construction details of all Temporary Shafts and their proposed locations along the tunnel alignment to the Engineer for acceptance. The submission shall also include details on shoring system, entry and exit arrangement, thrust wall layout and design details,generallayoutofguiderailandjackingtablearrangementetc.TemporarySha ftdrawingsare to include but not limited to:

1. Launch/jackingandreceptionshaftconfigurations.
2. Designandconstructionoflaunch/jackingandreceptionshaft.

3. Detailsforexcavationandbackfillingprocedures,groundsupportsystems,andgrou ndstabilization if required.

4. Specialrequirementsforjackingandreceivingshaftpenetrations, thrustblocks,backstopsorother reactions required for Microtunnelling/ pipe jacking/ auger boring, casing pipe jacking or any other jacking.

5. Fullcalculationssupportingmaximumjackingcapacitythatjackingshaftswillwithstand

6. Dewateringandgroundwatercontrolplansforalltemporaryandpermanent shafts.

The shaft shall be kept dry at all times and shall have a drainage sump to pump out the ingress water. The Contractor is deemed to be fully aware of the serious consequences to the tunneling equipment and other accessories if the shaft is flooded. He shall take every precaution to avoid flooding in the shafttheshaftshallbewellprotectedagainstsurfacerunoffgettingintotheshaft.Theco ntractorshall be solely responsible for any consequential delays and expenditure arising as a result flooding the shaft.

Theshaftfloorshallbedesignedtowithstandthetunnelmachineandother accessories.

The Contractor shall be solely responsible for providing and subsequent removal of shoring to the shaftsorpitsandensuringstabilityofthesidesofsuchexcavationsandsafetyofadjoinin gstructures.

The sizes of the shafts shall be kept as small as possible considering site constraints.Equipment manufacturer’sdataonrequiredshaft sizesshallbefurnishedtotheEngineeralongwiththebid.The sizes of pits shall take due cognizance of available space needed for jacking frame, shoring or feed pumps or other ancillary equipment, thrust wall and entrance ring.

Considering the ground and physical conditions at site, the shafts may be constructed using well sinkingmethodaspreferredmethod.Thecontractorshallbesolelyresponsiblefordes ign,erection and maintenance of the caisson shafts constructed by him using well sinking.

ConstructionofThrustWall

Thrust wall shall be designed and constructed by the contractor to the approved details. The thrust wallshall bereinforcedorunreinforcedconcreteconstructedagainstthewall ofthejackingshaft.The Contractor shall ensure that the thrust wall is constructed as an independent structure and it shall not interfere with the jacking shaft or the floor when jacking force is applied on to it. Contractor shall

indicateinhissubmittalstheconstructiondetailsofthethrustwallshowingdetailsonh
owthewallbe made independent of the jacking shaft structure.

TheContractorshallensurethat thethrust wallandthesoil behindareincompletecontactandthere is no gap between them. The contractor shall further ensure that the thrust wall shall effectively transferthejackingforceontothesoil behindandthatthegroundbehindiscapableofwithstanding the jacking force.

Intheeventthatthereisgapbetweenthethrustwallandthesoilbehind,theContractors hallarrange the gap to be filled with approved cement grout before loading the thrust wall.

InstallationofGuideRails/Jackingframe

The Contractor shall design and fabricate the guide rail / Jacking frame in accordance with the equipment manufacturer's details and install it firmly onto the floor of the jacking shaft. He shall ensurethattheguiderail/jackingframeisinstalledtothecorrectgrade,levelsandalign ment. Itshall be also square to the pipeline alignment at all times and not disturbed due to forces arising from the jacking operation. He shall arrange with the Engineer's representative to check the level, alignment etc., of the guide rail and obtain the Engineer's endorsement before commencing guide the pipe jacking work.

EntranceandExitArrangement

One of the most critical operations is the launching and retrieval (entry and exit) of the micro tunneling/boringmachine.Oftenthisprocesstakesplacewellbelowthewatertable.In thosecases,it is critical that the contractor implement adequate engineering measures including improvement of unstable soil by grouting or other means to prevent soil and water inflows into the shaft.

Itiscommonpracticetoinstallarubbersealattheentryandexit.Thesealistoprevent theflowof ground water or lubricant (usedforreducingthe frictionalresistance)through theshield/pipe entry opening on the shaft wall.

Anexit ringmust beprovidedwithoutexceptionifthestrataatthelevelofexit happenstobeloose.

TheContractorshallplanthisworkwellinadvanceandfabricatethefittingsandrubb ersealasper approved method.

Machineexitintothereceptionshaftwillnotbepermittedunlessthereceptionshaftisp rovidedwith proper exit ring.

SoilImprovementattheTunnelEntryandExit

In addition to the seal, it may be necessary to stabilize the soil behind the entrance wall. This is to preventanyfreeflowofunstablesoilsintothepitwhenopeningismadefortheshieldt oenter into

the ground. Chemical grouting, cement grouting, jet grouting, piles, ground freezing or temporary shoringaresomemethodscommonlyusedbythecontractorstopreventthesoilflowintotheshaft.

CementGrouting

TheContractorshallbefullyresponsibleforpreventingtheoccurrenceofvoidsoutsidethepipeand if they occur he shall fill them with cement grout. Immediately following the jacking operation the Contractor shall pressure grout the jacked section to fill all voids existing outside of the pipe. Groutingshallbefromtheinteriorofthepipethroughgroutingholesasspecified.Thegroutmixshall be at least of CM 1:3.

Systems of standard pipe, fittings, hose,andspecial groutingoutletsembedded inthe pipe wallsshall be provided by the Contractor.Care shall be taken to ensure that all parts of the system are maintainedfreefromdirt.Groutcomposedofcement,sandandotherapprovedcompoundandwater shallbeforcedunderpressureintothegroutingconnectionsattheinvertandshallproceeduntilgrout begins to flow from upper connections.Connections shall then be made to these holes and the operation continued to completion.

Apparatus for mixing and placing grout shall be of a type approved by the Engineer and shall be capableofmixingeffectivelyandstirringthegroutand thenforcingit intothegrout connectionsina continuous uninterrupted flow.

After grouting is completed, pressure shall be maintained by means of stop cocks, or other suitable devicesuntilthegrouthassetsufficiently.Afterthegroutisset,groutholesshallbecompletelyfilled with dense concrete and finished neatly without evidence of voids or projections.

Jacking System

Thehydraulicjackingsystemshall beinstalledagainstapurposebuiltthrust wall inthejackingshaft. The jacking force required for jacking pipes and the tunneling/ boring machine shall be provided by high pressure jacks driven by hydraulic power packs with appropriate factor of safety. The ram diameter and stroke of the jacks may vary according to individual contractor’s technique and to suite site conditions.

The jacks shall be mounted on specially made frames so that the jacks are square to the pipe alignment.Thejackingframeshall befirmlysupportedtothefloorsothatit doesnot moveduring jacking operation. A

push ring shall be used to transmit the jacking force evenly to the pipe.

Therearejackingsystemswithmultiplestrokesorlongstrokemountedonaspeciallym adejacking frame available to push a full-length pipe in a single setting. The system does not require the use of

spacersandhenceasubstantialincreaseinproductivitycanbeachievedbyusingmultiplestroke jacking system.

Jackingforce

TheContractorshallcalculatetheanticipatedjackingloadforeachmicrotunnel/pipejacking/auger boring drive well ahead of designing the jacking pipes. Accurate estimation of the jacking load is necessary to determine the pipe wall thickness, the need for intermediate jacking stations and lubrication requirements, types of jacking system and thrust block design. The overall jacking force depends on the type of surrounding soil, depth of cover, pipe materials, diameter and the overall length of the pipeline. The total jacking force essentially consists of two components, “Frictional force around the pipeline” and the balancing force at the tunnel face called “Face Pressure”. The Contractor shall use appropriate geo-mechanics formulae and guidelines for computing the jacking force.The contractor shall calculate the anticipated jacking force for each drive and submit his calculation to the Engineer for approval.

The Contractor shall be solely responsible to ensure that the pipes are not subjected to excessive jackingforceortorsionalforcesoastocrushthem. Ifsuchthingoccursthecontractorshall haveto remedy the situation at his risk and cost.

PipeLubricationSystem

The boring machines are commonly designed to overcut about 10mm (in some cases up to 20mm) around the external diameter of the pipeline.The pipeline can, in theory, be jacked freely through a fluid medium by injecting a clay based (bentonite) or polymer based lubricant into this annulus. In practice,however,fluidlossesmayoccurintothesurroundingground.Thecontractorshallcarefully monitor the jacking force and use appropriate lubrication system, to bring down the jacking force within the allowable jacking force for the pipe.

ProtocolofeachDrive

After completion of particular drive / workor as directed by the Engineer, Contractor shall submit within five days a proper & authentic `PROTOKOL’ (both soft & hard copy) of Micro tunneling machineryforthat particular drive /

work, totheEngineer. Protocol must reflectdatetime, length, variouspressuresofmainjacks,steeringjack’sextensions,andcutterheadtorque&facepressure,

slurry&feederpumps-flowrate,pumppressures,deviationsinvertical&horizontalalignment,roll, pitch etc.No extra payment shall be admissible for this requirement.

SpecialTrafficPrecautions

The Contractor's attention is specially drawn to the requirements by the traffic police and road authorities and Specifications regarding Traffic Control, Access and the Reinstatement of road surfacesetc.Itshallbetheresponsibilityofthecontractortoobtainpermissionsfromtraffic police and other authorities well in advance of the commencement of the works.

TheContractor'sprogress/ programmeandroadopeningschedulemustbearrangedindetailsfor discussion with the Engineer and the Traffic Police. The laying of pipelines must be broken into appropriate sections and where necessary special traffic diversions arranged.

Whenevercarriagewaysareaffected,theContractormustarrangetocontainthe workswithinthe narrowest possiblearea.Excavatedmaterial must beremovedastheworkproceedsorcontained within the areas designated by the Engineer/ Traffic Police.

TheContractorshallcarryout theworkinsuchamannerastocauseminimuminterferencewiththe public use of highways, footpath and other thorough fares.

All workmen workingon roads are required to wear approved retro-reflective vests at all times.

TheContractorshallincludeinhisratesforcompliancewithalltheconditionsstipulatedabove.

RoadOpening

Wheremanholeshavetobeconstructedonexistingmetalledorconcretedroad,theContractoris required to submit a detailed road opening schedule to the Engineer for approval.

TheContractorshallcontaintheworkswithinthenarrowestpossibleareawhenlaying pipelinesalong metalled or concreted road.

Trafficflowmustbemaintainedatalltimesalongtheroadsaffectedbythework.Sufficientlighting, road signs, barricades and traffic diversion signs must be established along the sites of the works in accordance with the Traffic Police requirements and to the entire satisfaction of the Engineer.

TheContractorshallalsocomplywiththeconditionsimposedbyTrafficPoliceandRoadsOpening Conditions and Requirements stipulated by any other Authority.

Upon the completion of the pipeline or manholes, the Contractor shall backfill and make good all disturbancestotheroad,sidetable,roadkerbanddrainstothesatisfactionoftheAuthoritiesandthe Engineer.

If required the pits shall be covered withdeckingplates with appropriate support so that all traffic shallbeallowedtorunoverthedecking.Noextrapaymentshallbeadmissibleforsucharrangements and the contractor’s rates shall be deemed to cover such requirement. If directed by the authorities or the Engineer, the Contractor shall construct temporary diversion roads at his own cost to allow the traffic to flow through during the construction.

PartialCoveringupofRoadinBusy Areas

Where it is unavoidable to locate manhole shafts or workingshafts for tunnelsin busyroads,thetop oftheopeningsshallbecoveredbydecking,leavingonlytheminimumrequiredareaopenatthetop to carry out work within the shaft.Vehicles shall be permitted to travel over such covers provided. The Contractor shall submit to the Engineer details of the partial covering.He shall allow for compliance of this requirement in his rates.

ReinstatementofRoadandaffectedSurfaces

The Contractor shall carry out the reinstatement of road foundation and road surface in accordance with the Specifications and requirements of the Engineer and as stipulated in the contract specifications.Thisshallincludemachine-pavingasandwhendirectedbytheEngineer.Whereroad markings are affected, the Contractor shall reinstate with thermoplastic instead of paintings to the satisfaction of the Engineer.

Safety

The Contractor shall provide adequate ventilation and efficient apparatus to keep all excavations, tunnels and pipelines free fromall dangerous gases, whether generated in the soil strata or otherwise, andheshalltakeprecautiontoascertainthattheyareinasafeconditionbeforeallowing hisworkmen to descend.

While working in existing pipeline or manhole, the Contractor shall provide air blowers to ventilate the place as sewage gas usually contains a high proportion of hydrogen sulphide, methane and other toxic gasses which in combination with oxygen is explosive.Approved gas monitors/detectors and oxygen meters shall be used to ensure that the place is free fromall dangerous gases.The Contractor isrequiredtoappointaHealthandSafetyEngineer(AccidentPreventionOfficer)toascertainthatthe pipeline or manhole is in a safe condition before allowing his workmen to descend and work.No smoking or naked flame shall be allowed in the pipeline or manhole. Monitoring of the air quality shall also be carried out regularly by the Contractor's supervisor while work is in progress and work shall be immediately suspended should unsafe conditions develop.

The Contractor is warned that besides performing any work in existing pipeline or manhole, connecting to or breaking into existing pipeline or manhole also poses potentially hazardous conditions.Theexistingpipelineormanholetowhichconnectionistobemadeshouldthereforebe thoroughly ventilated and certified as safe by the Supervisor/ Safety officer before workmen are allowed to execute the connection.

TheContractorandhisSupervisor/ Safetyofficershallbesolelyresponsibleforsafetyofpersons entering in to the pipelines or confined spaces like manholes/ pits.

Continuousworking

If, in the opinion of the Engineer it is necessary, by reason of the safety of the works, or the restoration of interrupted services or for anyother reason whatever, the Contractor shall, when so orderedcarryouttheworksoranyportionthereofcontinuouslybydayandbynightwithoutextra charge and allow for such a contingency in his Bid price.

Itshallbeclearlyanddefinitelyunderstoodbythecontractorthatnoclaimsinrespectof anyofthe above shall be allowed in the settlement of the Final Account.

Steeltrenchingworks

Wherever the sub-soil conditions are expected to be of a soft and unstable character, the normal methods of timbering may prove insufficient to prevent subsidence of the adjoining road surfaces, drains and canal and other services or adjoining buildings and structures, in such circumstances the Contractorwillberequiredtousesteeltrenchsheetingorsteelsheetpilingadequately supportedby timber or steel struts, walling, etc.

SteelsheetpilesshallconformtotheprovisionofI.S2314orB.S.4360andshallbedriven where required as directed by the Engineer.

The Contractor will be required to design the layout of the piling and the overall dimensions of the excavationtosuitthesheetsandcornersavailableandtogivesufficientworkingspacef ortheproper construction of the work.

The Contractor will be expected to supply, pitch, drive and subsequently remove trench sheeting or pilinginaccordancewithotheritemsoftheSpecificationandtheterms“timber”or“tim bering”shall also apply to steel trench sheeting or steel sheet piling throughout.

Alternatively,theContractormayusetrenchboxescapableofsupportingthegroundin thegiven conditions. However, no extra payment shall be made on this account.

Contractors shall be solely responsible for design, installation and removal of any shoring or timberingorsheetingsystemandtheiradequacyandsafety.Theratesquotedby theContractorsshall be inclusive of such measures of providing steel sheeting or sheet piling.

Sewageintheconnectingsewers

ThepipelinesinstalledunderthisContractaremeanttoconnecttotheexistingfunction ingupstream and downstream functioning sewers. These pipelines are carrying sewage (stagnant or flowing) and may also be in surcharged conditions at times.

Connectiontoexistingsewers

The Contractor shall note that the connecting pipelines/ branches might have been laid sometimes backandwouldbefullofstagnantsewage/waterandmightalsohavesomeunknownco

nnections. The methods adopted by the contractor for making connections of such lines shall take due cognizance of such circumstances as no extra payment shall be made on such account.

TheContractorshallnotethatinconnectingpipelinestoexistingsewers,everycaresha llbetakento ensure that the connections are watertight and the existing pipelines are not damaged.Special precautionary measures shall be taken to ensure the stability of the pipelines connected to them.

The Contractor shall ensure that there is no interruption to existing flows during the connection works.No debris shall be allowed to fall or be discharged into the existing pipelines or manholes.
Anydebriswhichfallsintotheexistingpipeline/manholesandanyobstructionsthereb ycausedshall be removed at the Contractor’s expense immediately.

Allconnectiontoexistingpipelinesshallbesubjecttowatertightnesstestandmustmee tthe requirement for the same.

It shall be noted that during connecting the newly laid sewer line to the existing sewer, or for connectingcrosssewerstothenewlylaidsewer,ortorepairexistingsewer,thecontrac torsshallmake necessaryarrangementathisowncost, toprocurePneumaticplug/ Inflatableplug/mechanicalplug/ Pillow plug for plugging existing sewer line. Plugging existing sewer by using mud / sand filledgunny bags will not be permitted. Plugging shall be done in co-ordination with & as directed by concerned staff of Main Sewer Dept of BWSSB.

Safety measures for use of Sewer Plugs - Contractors need to ensure that the sewer plug is inspected priortoeachuse.Theplugshallbepartiallyinflatedandinspectedunderlowpressurefo ranyobvious wear, tear, cuts, abrasions or damage.Also, examine the accessories with which the PLUG is to be inflated.

Inflation pressures as in the Manufacturer’s instruction manual and on the plug, must be adhered to when inflating the plug, but never exceeds the max. Working pressure. Check the internal pressure in the PLUG regularly.

Utilizing an air line extension plugs can be inflated from a distance, away from the danger zone or outside

The PLUGS shall only be used by persons who have been properly instructed and who are trained for the use.

When using the PLUGS, the safety of the user and any bystanders must always be borne in mind, as wrong use can cause life threatening situations.
Contractors shall consider measures to brace for and absorb the impact of plug failures and to prevent the PLUG fromslidingout.This mayinclude anchoredropes/cables in upstreammanholes, bracingin the chase of the plugged manhole, or a combination of methods, all with associated risk assessments and

controls in place.

Ensureonlytheuseofapprovedandcalibratedpressuregauges.Andalsoensurepressuresare monitored and controlled during plug inflation / deflation with calibrated gauges.

TheContractorshallallowforalltheaboveinhis rates.

Layingpipelinesinresidential areas

TheContractorshallnotethatifthepipelinehastobelaidinclose proximitytoexistingpremises.He shall take all necessary precautions, including the provision of steel sheet piling cut-off walls where necessary,topreventanydamagetotheexistingpremisesandshallberesponsiblefor thedamageand complete repairs of the same.

The Contractor shall be responsible for obtaining permissions from the owners of private premises if neededbyhimforhiswork.Heshallberesponsiblefor restrictinghisworkmentothesiteofthework while working in private premises. If the Contractor considers it essential to have additional working spacehe mayobtainthesame fromprivate propertyowners entirelyat hisriskand cost.The Engineer is not bound to arrange for such facilities from private property owners.

Temporaryfencingshallbeerectedasdirectedbytheengineertoseparatetheworksitefromtherest of the private premises at the Contractor’s own expense for all execution.

Turf, walls, slopes, fencing, shed or any other structures whether directlyor otherwise disturbed or damagedbytheconstructionworkshallbereinstatedtotheoriginalconditionsbythe Contractorat his own expense.

TheContractorshallallowinhisratesforcomplyingwiththeserequirementsasnoclaimtothe contrary will be entertained by the Employer/ Engineer.

HydraulictestingofSewerline&Handingoverofcompletedworks

Upon completion of works the sewer lines including rising mains shall be hydraulically tested as per the required head/ pressure as per CPHEEO manual provision of specifications. After successful testing, the contractors must cleanthesite as per the satisfaction of the Engineer and thesame shall be handedoverbythecontractortotheuserdepartmentunderproperacknowledgement andcertificateto this effect.

Hydraulictestingandcleaningupthesiteoncompletionistobedonebythecontractors at hisown cost and no extra payment shall be admissible for this requirement.

Allworkstobewatertight

(a) Thedrains, manholes and alljoints ofpipes must be madethoroughlysound andwatertight, and any joint which may be proved to be leaky at any time during the progress of the works or during the contractors' subsequent period of maintenance shall be immediately made sound by the contractors at their own expense. The contractors, when required by the Engineer shall at their own cost prove all works to be water tight by filling it with water to such height as the Engineer may determine. Any additional precautionary measure or appliances that may be found necessary to ensure the water tightness of the manholes, flush tanks, disc plug in junctions and the joints of pipes shall be adopted by the Contractor without extra charge, the responsibility of making them completely water tight resting upon the contractors.

Complete sewer inspection of inside of pipe shall be carried out with help of CCTV sewer inspection camera and a record of the same shall be maintained in the form of CCTVfootage with proper indexing/ subtitles/ overlays etc and submitted to the Engineer (3copies) on DVDs..

(b) Immediately after the CCTV pipe inspection has been completed and any defect discovered therein has been made good the Contractor shall prove the joints of the stretch of under- ground carrier pipes, to be water tight by filing in pipes with water before filling in thetrench to the level of 1.50 M above the top of the highest pipe in the stretch and heading the water up for the period of one hour or such further time as the Engineer may direct. The apparatus used for the purposes of testing shall be approved by the Engineer.The contractor if required bythe Engineer shall make the excavation dryand keep it so duringthe period of
testing.Notestappliedtopartofastretchofpipesshallbeconsideredconclusiv enorshallit be deemed to obviate the necessity of an application of the test to the whole of stretch when completed. The loss of water (ex-filtration) or rise in water volume (infiltration) over a period of 30 minutes should be measured by adding water from a measuring vessel atregular 10 minutes and noting the quantity required to maintain the original water level. For the purposes of this test the average quantity added should not exceed 1 litre/hour/100 linear metres/10 mm. of nominal internal diameter.

Works not within above specified requirements shall stand rejected and shall be rectified by the Contractor at his risk and cost.

The manholes when they have been raised above the highest subsoil water level expected in the monsoon shall similarly be tested for water tightness as for the pipe lines.The procedure for this shall be as follows:-

The mouths of all pipes entering the manhole shall be suitably plugged with

brick, masonry orwooden or any other type of plug. The manhole under test shall then be filled with water up to the general sub-soil water level and observed for a period of one hour. If the level does not drop by more than 50 mm. in one hour it shall be assumed that the manhole is water tight.

Note for pipe laid by open trenching only: During the period of the test the outside trench shall bekept free from any accumulation of subsoil water in case of a drop of more than 50 mm in the water level the contractor shall note the places from where the leakage is taking place & take steps to stop the leakage.

(c) Cleaningofthe pipes
Theopenend of anincomplete stretchof pipeline shall be securelyclosed as maybe directed by the Engineer to prevent entry of mud or silt etc.

(d) If as a result of the removal of any obstructionthe Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be retested at the expense of the Contractor. Should such retest prove unsatisfactory, the contractor shall at his own expense amend the work and carry out such further tests as are required by the Engineer.

(e) It shall also be ascertained by the Contractors that each stretch from manhole to manhole is absoluteclearandwithoutanyobstruction by meansof CCTVinspectionoftheinterior ofthe pipe line.

Allworkstobeclear,cleanandperfect

The contractors shall after completion or whenever required by the Engineer, prove all pipes and fitting to be clear clean and perfect, and for this purpose shall, at their own expense and in the presenceoftheEngineerorhisappointee,providesuitableinstrumentsandappliance sandpassthem through the pipes and shall if required, throw in water and show that it passes freely through every portionofthework.Brick,mortarandrubbishshallnotbeallowedtofallintothemanhol esofsewer lines while fixing or if allowed, shall be removed by the Contractors at their own expense.

RemedialMeasurestobeadoptedbytheContractor

TheContractor shall take each and everyprecautiontoensure that the tunnelingor drillingequipment willsuccessfullyexcavatealongthechosenpipelinealignmentbeforehecommencest heoperation.In the event of inability to complete the drive, due to break down or any other reasons, the Contractor shall be fully responsible to recover the equipment safely from the ground and restore the incomplete work to the original condition at his risk and cost by a method agreed with the Engineer and the concerned authorities within the time stipulated by the Engineer or the concerned authority.

The cost for such retrieval measures or any consequential expenditure or delays arising from thereof shall beentirelybornebytheContractor.Anyfailureofremedial

measuresshallbeentirelyattherisk and cost of the Contractor. Any abandoned hole or tunnel must be backfilled to the top of the hard strata with concrete or gravel with grouting to provide a solid infill, or other method agreed with the Engineer completely at the Contractor’s cost so as to prevent subsequent settlement.

InspectionandReplacementofDefectiveWork

(a) At anytime duringor afterthe execution ofthe Works the Contractor shall, attherequest of the Engineerand within such time asthe Engineershallname, open for inspectionanywork coveredupandshouldtheContractorrefuseorneglecttocomplywithsuchrequest,heshall employ other workmen to open up same.

(b) If the said work has been covered up in contravention of the Engineer's instructions, or if on being opened up it be found not in accordance with the Drawings, Specification and Bills of QuantitiesortheinstructionsoftheEngineer,theexpensesofsuchopeningandcoveringitup again, whether done by the Contractor or such other workmen, will be borne by and is recoverable from the Contractor.

(c) Wherever intheopinionoftheEngineertheworkdoneisinadequateorofpoorworkmanship or inferior materials or in any way sub-standard such works will be demolished, cut out and removed from the Works immediately and replaced with new materials of the required standard and quality at the Contractor's risk and cost.

Takingphotographs

Contractorathisowncostshalltake,print,supplyalbumofphotographs(Twosets)inanalbum during the construction work in progress. The photographs shall be submitted fortnightly or as directed by the Engineer. No extra payment shall be admissible for this requirement.

CCTVSurvey

It ismandatoryforthecontractortocarryout CCTVSurveyincludingsubmissionoftwosoft copies &twohardcopiestotheEngineeraftercompletionofparticulardrive/ workalongwithmanholesor as directed by the Engineer. No extra payment shall be admissible for this requirement.

Handingoverofcompletedworks

Anypipeorlengthofpipesfoundtobedefectiveshallbeimmediatelyremovedandreplacedatthe Contractor's expense and leaking joints shall be remade, the inspections and tests shall then be repeated as often as necessary until the whole line under inspection or test is accepted by the Engineer.

Uponcompletionworksandsuccessfultestingofcompletedworksthesameshallbehandedoverby the contractor to the user department under proper

acknowledgement and certificate to this effect.

EndofPart-10B

PART11
GENERAL&PARTICULARMECHANICALREQUIREMENTS

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PART 11

GENERAL&PARTICULARMECHANICALREQUIREMENTS

WetWells

(a) In order to prevent surcharging of sewers, the maximum level of sewage in the Inlet Chamber of the ISPS shall be limited to 1000 mmbelow the invert of the lowest incoming sewer.

(b) For the ISPS, in order to prevent sewage from turning septic, maximum retention of sewage in the wet / suction well shall not exceed 30 minutes for the average flow.

(c) The depth of sump shall be such that it provides at least 15 % margin over the minimum required pump submergence calculatedat dutypoint on the basis of theHydraulicInstitute Standard.

(d) The wet well effective operating volume (volume between low level where all pumps are shut off and high level where all pumps except standby are operating) shall be such thatthe hydraulic retention time in this volume at peak flow is not less than 5 minutes and the number of starts per hour does not exceed 6 for any single pump under any circumstances.

(e) Appropriate baffles shall be provided in the wet/suction well to prevent the excessive turbulence and air entrainment when free fall of material to be pumped occurs.

(f) Benchingshall be provided at the bottomof the wet well towards the suction bell mouthto ensure that the pumps can be used to completely drain the wet well.

(g) The wet well design shall incorporate corner fillets and ogees as appropriate to eliminate dead spots, prevent accumulation of solids or

debris, and to ensure that the wet well isfully self cleaning – automatically cleaned by the hydraulics of the flow.

(h) Primingofpumpsshallbeensuredbyprovidingpositivesuction head.

(i) Operationofsewagepumpsshallbeautomaticbasedonthesewagelevelsinthewet well.

(j) Standby unit of each type and size of pump employed shall be provided as specified in particular mechanical requirement and these shall be minimum requirement.

(k) The clearance between pumps outer periphery (or pump foundations) shall be not lessthan 1000 mm.

(l) Sequence of operation of raw sewage pumps shall be changed every 8 hours to avoid accumulation of solids in the wet/suction well.

(m) +5%marginonthepumpcapacityshallbeprovidedforallthepumps.

(n) The total head of the pump shall be selected considering peak flow and maximum design level in the wet well for normal conditions of operation and checked for satisfactory operation under extreme conditions of operation; the selected head to be revised ifrequired.

(o) The minimum permissible velocity in the pumping mains shall be 0.6 m/sec. The maximum velocity in the pumping main shall not exceed 2 m/sec.

(p) The top of the wet well wall, top of valve chamber walls and top of electrical cubicles structures shall be minimum of 500 mm above the finished ground level. No Buried/ Submerged structures shall be accepted for the wet well.

(q) All drywell pumpingstations shall be provided with a pit and drain pumps (1 working+ 1 standby) to automatically empty the stuffing box drain.

(r) Ventilationshallbeprovidedforthepumpingstationbasedon10-12airchangesper hour.

(s) For ISPS, mechanical rake coarse bar screen shall be provided

upstream of the pumping station wet well. Provisions shall be made to allow lifting of screenings by belt conveyor.

(t) Appropriate lifting devices shall be provided for safe and easy retrieval and/or removal of the pumps from wet well or dry well for maintenance or any other purpose at all pumping stations.

(u) On the Common header of ISPS, Sludge and other pumping systemshall be provided with Motorised Knife Gate Valve on upstream of Flowmeter and Swing Check Valve on downstream side.

SubmersiblePumps(MainPumps&Dewatering Pumps)

General

Pumps and drives shall be rated for continuous duty and shall be capable of pumping the flow range specified in the specifications without surging, cavitations or excessive vibration to the limits specified. The pump shall meet maximum allowable shut off head. The pumps shall not overload the motors at any point on the maximum pump speed performance characteristic curve and the pump operating range within the limits of stable pump operation. The total head capacity curve shall be continuously rising towards the shut off as flow decreases throughout the entire curve from run out to shut off head with the highest at shut off. Pump shall be compatible for Variable Frequency Drive usage.

10. Itstotalheadcapacitycurveshallbecontinuouslyrisingtowardsshutoffwithe highest at shut off, and its capacity shall be meet to handling sludge volume.

(a) Pumps shall be suitable for single as well as parallel efficient operation at any point in between the maximum and minimum system resistances.

(b) Thepumpsshallbedesignedtohandlesolidsizesofupto100mmfortherawsewage application and 50 mm for all other process fluids. Specific gravity of sewage is 1.02.

(c) Pumps shall run smooth without undue noise and vibration, cavitations, oil or water leaks over therangeofoperation.Toensurevibrationfreeoperation,allrotativecomponent

sofpump shall be statically and dynamically balanced to BS 6861/.as per zones A& B of ISO 10816 -1 Vibration levels shall not exceed the levels given in BS 4675.

(f) Thepumpsetshallbesuitableforstartingwithdischargevalveopenand/or closed.

(g) Thepumpsetshallbecapableofwithstandingtheaccidentalrotationinreverse direction.

FeaturesofConstruction

(a) Pumpshallbecentrifugal,verticalspindle,non-clog,wearresisting,andsinglestagetype.

(b) Pump casing shall be of robust construction. Liquid passages shall be finished smooth and designed as to allow free passage of solids. The volute tongue shall be filed to a smooth rounded edge.

(c) Double Mechanical seals (back-to-back) shall be provided to protect the motor from ingress of sewage along the shaft. The preliminary and secondary seals shall be oil-lubricated with tungsten carbide or silicon-carbide faces and they shall be equipped with an electrical monitoring system for seal failure detection. Seals must be capable of withstanding rotation in either direction. A detector shall indicate when moisture is leaking past the first seal.

(d) Impeller shall be non-clog enclosed type with smooth blunt edges and large water ways so as to allow free passage of the large size solids.It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials.

(e) Thecriticalspeedoftherotorshallbeatleast30%abovetheoperatingspeed.

(f) Pump-sets shall have double bearings. Bearings shall be of the anti-friction type. Bearings shall be capable of taking the static weight of the rotating parts and any thrust generated by the operation of the pump. The bearing life shall be minimum 40,000 hrs of operation.

(g) Each pump shall be complete with a cast iron delivery connection arrangement for fixing to the concrete floor of the suction well.The joint between the pump discharge flange and the delivery piping shall be made by merely lowering thepump into guide rails / ropefrom access level.It shall be provided with all necessary fixings for guiding the pumps during

lifting/lowering.Each pump shall be provided with a SS 316 lifting chain conforming to BS 1663 and BS 4942.

(h) Each pump shall be provided with an automatic coupling device for attaching the crane hook to the pump at low level, even whilst the pump is submerged, without the need for personnel to enter the well.This automatic coupling device shall easily and automatically couple and uncouple the hoist hook and be complete with necessary accessories.All links and cables shall be multi-stranded stainless steel.

(i) Thematerialsofconstructionforsubmersiblepumpsshallbeasfollows:

S. No.	Component	Material
(i)	Impeller*	StainlessSteel:ASTMA743CF8 M
(ii)	Casing*	CastIrontoIS:210GrFG260with 1.5 to 2% Nickel
(iii)	Mechanical seal (MotorsideandPump side)*	oil-lubricated with tungsten carbide or silicon-carbide faces
(iv)	Shaft*	StainlessSteel:BS:970Gr316
(v)	Bush*	BronzeIS318Gr.LT B2
(vi)	Guiderailpipe	StainlessSteel:BS:970Gr304
(vii)	LiftingChain	StainlessSteel:AISI316
(viii)	FastenersandFoundation Bolts	StainlessSteelAISI316

*MaterialtestcertificatesfromGovernmentapprovedmetallurgicallaboratoryshallbe furnished by the Contractor

(j) Each pump shall be tested at the manufacturer’s premises for the full operating range of the pump to BS 5316 Part 1. Pump performance shall be within the tolerance limits specified in the above said BS.

Data:

Pumpparametersaretobeachievedatthemotorspeedcorrespondingtothefrequencyof50Hz.

Sr. No	**Description**	**Particulars**		
		MainWetWell	**Dewatering Pumpinwet well**	**Emergency Drainage/ Dewatering Pump for Manhole/Chamber /Scre en channel**
(a)	DesignCapacity(m^3/hr) (Minimum)	938	20	50
(b)	TotalHead-Including Station Losses (mwc) (Minimum)	20	18	15
(c)	SynchronousSpeedat 50 Hz (rpm)	1500 (maximum)	1500 (maximum)	1500 (maximum)
(d)	NumberofPumps (Nos.)	4Nos.(2W+2S)	2Nos. (1W+1S)	2Nos.(1W+1S)
(e)	TypeofPump &Arrangement	Non-clog Submersible pumps with Guidepipe &Chain arrangement	Non-clog Submersible pumps with Guidepipe &Chain arrangement	Non-clog Submersible pumps Chain arrangement and Hose Pipingupto50mwith 50 m cabling

L.V. Motors

11. Motorsshallbesuitable ofstartingand acceleratingthe load withtheapplicablemethod of starting, without exceeding acceptable winding temperatures, when the supply voltage is 85% of the rated

motor voltage.

12. The locked rotor current of the motor shall not exceed 600% of full load current(subject to tolerance as per the applicable standard).

13. Motorsshall be designedtowithstand 120% of rated speedfortwo minutes without any mechanical damage, in either direction of rotation.

14. Stator leads shall be brought to the terminal box as insulated cable through a suitable barrier and terminated in clamp type terminals.

15. Motors rated 30 kW and above shall be provided with space heaters with adequate capacity to maintain motor temperature to prevent moisture condensation on the insulation during idle condition.The space heaters shall be suitable for 240V single phase 50 Hz supply.Separate terminal box shall be provided.

InductionMotor(SubmersiblePump)

PerformanceandCharacteristics

a) The submersible motor shall conform to IS: 9283 and the submersible cable shall conform to clause no.4.4 ofthe IS: 9283. The motorsshall be suitable for operatingon a 415V, 50 Hz, 3 phase, Ac supply. Pump motor shall be of the squirrel cage submersible type, protected to IP
68. Motor for submersible pump shall be capable of startup and operation in the event of a completely flooded wet well. Motor cooling for submersible pump must be achieved by a cooling jacket, using the pumped media to cool the motor. The pump impeller must be equipped with a systemto ensure a pumped flow of liquid through the coolingjacket and also incorporate a device to prevent the liquid channels from blocking with hair and foreign material. This motor shall be capable of starting 10 times per hour. The insulation class of motor winding shall conform to class F. Additionally the specific requirements mentioned in the following clauses shall also be met.

b) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:

(i) Variationofsupplyvoltagefromratedmotor voltage ±10%

(ii)	Variationofsupplyfrequencyfromratedfrequency	±5%
(iii)	Combinedvoltageandfrequencyvariation	±10%

16. The starting current of motor shall not exceed 200% of rated full load current for star/delta starting and600% of rated full load current for DOL starting, underany circumstances.

17. Motors shall be suitable for full voltage direct-on-line starting or star-delta starting. All the motors shall be VFD Compatible only.

18. Motors shall be capable of startingand acceleratingthe load withthe applicablemethod of starting, without exceeding acceptable winding temperatures, when the supply voltage isin therange 85%of the rated motor voltageto maximumpermissible voltage.

19. The locked rotor current of the motor shall not exceed 600% of full load current(subject to tolerance as per the applicable standard) unless otherwise specified.

20. Motorsshall be designedtowithstand 120% of rated speedfortwo minutes without any mechanical damage, in either direction of rotation. The motor vibrations shall be within the limits specified in applicable standard unlessotherwise specified for the driven equipment.

21. Except as mentioned herein, the guaranteed performances of the motor shall be metwith tolerances specified in applicable standard, IS: 9283.

22. Motor insulation shall conform to Class F and the maximum temperature rise shall not exceed 95 deg C, when measured by winding resistance method and 85 deg C, when measured by thermometer method for an ambient temperature of 45 deg C. The motor windings shall be protected with a waterproof material and shall incorporate a thermal sensor in each phase to safe guard against high winding temperatures. The thermal sensor shall be connected into the control circuit of the starter and signals taken for continuous monitoring of winding temperatures. The motor shall incorporate a cut out device to detect the presence of any liquid in the motor enclosure, in the form of non resetting moisture switch. The terminal connections for the power and protectivecircuits shall be housed in a completely sealed and water proof junction box, complete withallexternalcorrosionresistantcableglands.Thepump

unitsshallbeprovidedwith power and protection circuit cables of sufficientlengthto reach fromthe motorjunction box to the local isolator located at the panel floor level.

23. Protection against increase in stator winding temperature (150°C) bearing temperature, leakage in stator housing and terminal box shall be provided.Minimum three number thermistorsinseriesaretobeprovidedtosensethestatorwindingtemperature.Sensors are to be provided to detect if leakage of sewage into the oil housing is above 30 % concentration.

24. Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

25. Thepowerratingofthemotorshallbelargerofthe following:

(i) 115% of the power input to the pump at duty point at a speed corresponding to the frequency of 49 Hz.
(ii) Maximum Power input while operating single pump corresponding to the speed of 50 Hz.

26. MotorshallbeofferedforroutineandtypetestsinaccordancewithIS:4029 and IS:12615/IS 15999/IS-IEC 60034 at the manufacturer’s works.

SubmersibleCable

(a) The submersible cable shall conform to clause no. 4.4 of the IS: 9283. The power cable shall be PVC insulated and PVC sheathed, flexible, 3.5 core flat type. The size of the conductor shall be adequate for continuous use under water and air. The half core shall be used for earthing.

(b) The control cable shall be PVC insulated PVC sheathed, flexible, flat type and shall be adequate for continuous use under water and air. The control cable for stator winding temperature sensor (Thermistors) 3 core x 2.5 sq. mm copper conductor and for bimetallic thermal switch 2 core x 2.5 sq. mm copper conductor shall be provided.

(c) In case a joint is required to be made between the lead cable supplied with the motor and the user's cable connectors, a detailed procedure of cablejointingto make a watertightjointshall be provided by the manufacturer.

(d) The size of the conductor and length of cable should be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

Earthing

27. Earthing of the motor shall be done in accordance with the relevant provisions of latest revision of IS: 3043. For the purpose of earthing these motors, earthing connection may be made to discharge pipe.

Insulation

(a) Any joints in the motor insulation such as at coil connections or between slot and end winding sections, shall have strength equivalent to that of the slot sections of the coil.

(b) Theinsulation shall be given tropical andfungicidal treatment forsuccessful operation of the motor in hot, humid and tropical climate.The tropicalising treatment shall be as per the applicable standard.

(c) The stator winding shall be made from high conductivity annealed copper conductor, PVC insulated winding wires conforming to IS: 8783 for wet type motors.The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS: 4800 (Part-VII) for dry type motors.

TemperatureRise

28. The temperature-rise test of the motor shall be taken with the motor coupled to the suitable pump to give the full load output of the motor.When the various temperatures are stabilized, the set is stopped and the temperature-rise of the stator winding by the resistance method shall notexceed 35°C. Duringthetest, the temperature of the cooling water may not exceed 35°C. As the cable resistance will also be substantial, it is necessary that while calculating the temperature rise by resistance method, due care is taken to account for the correct hot and cold resistance of windings.

ConstructionalFeatures

29. Themotorshallbesuitablefor continuous useinfullyor

partiallysubmerged condition. Abuiltincoolingsystemmustallowthemotortooperatecontinuouslyatitsrated

output regardless of whether the electric motor is submerged or not, by providing either external or internal cooling arrangement.

Terminal Box

30. Terminal box shall be of weather proof construction to eliminate entry of water anddust.

31. Theterminalsshallbeofthestudtypewithnecessaryplainwashers,spring washersand check nuts.They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearance.

Valves

(a) Valves shall be as per internationally recognized standards. Flanges shall be machined on faces and edges.Flanges shall conform to ISO 7005, IS 6392, BS EN 1092-1/ BS 4504.

32.

(b) Valves shall be double flanged type and the facesshall be parallel to each other.Theflange face should be at right angles tothe valve centreline. Backside of valve flanges shall be machined or spot faced for proper seating of the head and nut.

(c) Valves buried or installed in underground chamber, where access to a hand wheel would be impractical, shall be operated by means of extension spindle and/or keys. Wherever extension spindle is provided, the valve shall also be provided with suitable headstock.

(d) Valve of diameter 450 mm and above shall be provided with lifting eyes and shall have detachable bolted covers for inspection, cleaning and servicing.

(e) Valve shall be suitable for frequent operation as well as operation after long periods of idlenessin either open or closed position.

(f) The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel.

(g) Valvesshallbefreefromsharpprojectionswhicharelikelytocatchandholdstringymaterial.

(h) Allthevalveshallbeof10bar rating.

(i) AllthevalvesonthesuctionanddeliverysideoftheIntermediateandTerminalsewagepumping station shall be of Motorised Knife gate type.

(j) Allvalvesintheplantshallbeprovidedwithdismantlingjoint/Flexiblejointforease dismantling.

(k) AllthevalvesshallbeprovidedwithBypassvalvearrangement10%ofmainvalvesize.

ElectricActuator

(a) Alllocalcontrolsshallbeprotectedbyalockablecover.

(b) Each actuator shall beadequatelysized to suittheapplication and be continuouslyrated to suit the modulating control required.The gearbox shall be oil or grease filled, and capable of installationinanyposition.Alloperatingspindles,gearsandheadstocksshallbe providedwith adequate points for lubrication.

(c) Thevalveactuatorshallbecapableofproducingnotlessthan1½timestherequired valvetorque and shall be suitable for at least 15 minutes continuous operation.

(d) The actuator starters shall be integrally housed with the actuator in robustly constructed and totallyenclosedweatherproofhousing.Themotorstartershallbecapableofstartingthemotor under the most severe conditions.

(e) Thestarterhousingshallbefittedwithcontactsandterminalsforpowersupply,remotecontrol and remote positional indication.

(f) Eachstartershallbeequippedasfollows:
   (i) 2No.Threephasemagneticallyoperatedlinecontactorswithno-voltreleaseand electrical and mechanical interlock.
   (ii) 1No.Threephasethermalcut-out device.

(iii) 1No.Controlcircuittransformerfullyprotectedbyfusesonprimaryan dsecondary circuits.
(iv) 1No.Setof“Open”,“Close”and“Stop” buttons.
(v) 1No.Local-Off-Remoteswitcheswithpadlockingfacilities.
(vi) 1No.Setoftorqueandlimitswitchesfor“Open”and“Close” positions.
(vii) 3No.Setsofauxiliarylimitswitchesineach direction.
(viii) Valve position Analog Transmitter (i.e Actuator accept To Read Analog signal from ActuatortoPLCandalsoToWriteAnalogSignalfromPLCtoActuator)&mechanical indicator and hand wheel for manual operation.
(ix) Reductiongearunit
(x) 1No.monitorrelay(todetectlossofphase,thermostattripped,localstopP Blockedor local mode selected)
(xi) TripsignalsofThermoswitch,TorqueSwitchandThermalOverloadRelayshallbe provided for Indication and also integrated to PLC.

SluiceValves

(a) AlltheSluicevalveshallbeofMetalseated,designgenerallyconfirmtoBS5163-89/ IS 14846.
(b) Sluicevalvesshallbeofnon-risingspindletype.
(c) Valves of 400mm and above shall be provided with thrust bearing arrangement for ease of operation.
(d) Valves of diameter 400 mm and above shall be provided with enclosed gear arrangement forease of operation.The operation gear of all valves shall be such that they can be opened and closedby one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed arequired rim pull of 400 N.
(e) All valves, spindles and hand wheels shall be positioned to give good access for operational personnel.
(f) All the hand wheels shall be arranged to turn in a clockwise direction to close the valve.The direction of rotation for opening and closing of the valve shall be indicated on the hand wheels.
(g) Thematerialofconstructionofvalveshallbeasfollows:

Component	**Material**
Body/Dome/ Bonnet	SGIronIS1865Gr.500/7/GGG50or400/15/ GGG40
Wedge	SGIronIS1865Gr.500/7/GGG50or400/15/ GGG40
Spindle	StainlessSteel;ASTMA276Gr.431S29/420
Thrustcollar&WedgeNut	Bronze:IS:318GrLTB2

Component	**Material**
Seals	FoodGradeEPDM
O-Rings	NBR
Seat/ face Rings	BronzeIS318Gr.LTB2/SS316
BackSeatBush	BronzeIS318Gr.LTB2/SS316
ShoeandChannellining	BronzeIS318Gr.LTB2/SS316
Internal Fasteners	SS316
ExternalFasteners	SS316
Gear,Gearhousing	CastSteelASTMA216Gr.WCB

Data:

Sr. No.	**Description**	**Particulars**	
		ScourPurposein Pumping Main	**Servicewaterpump delivery line & distribution System**
(a)	Size(mm)	150	40
(b)	Quantity	1	10
(c)	PressureRating(bar)	10	10
(d)	Time of opening from fully opened to fully closed position (minutes)	Nil	Nil
(e)	Typeof operation	Manual	Manual

KnifeGate Valves

DESIGN&CONRUCTIONALDETAILS:

The Knife gate valves shall be manufactured generally as per the latest AWWA C520-10 standards/MSS SP 81.

Otherconstructionalfeaturesanddetailsofcomponentsoftherequiredvalvesaretobeas under:

The valve body should be of ductile iron construction as specified.The valve should be provided with gate made of stainless steel of grade as specified and the gate should have beveled knife edge at the bottom to cut through and easily enter in the solids settled in the bottom and ensure positive shut-off / closure in sewage environment.

TheValveshouldbedesignedforsealinginuni-directionalflowapplication.

The valve should be provided with replaceable type flexible sealing arrangement to offer drop tight shut off. The seals should be made of EPDM rubber and should be held in place by aneasily removable type seal retainer ring. The seals should be mechanically retained in place in a machined groove on the face of seal retainer ring. The sealing systemshould be field replaceable at site.

The valve housing should have integral as cast tapered lugs provided for pushing the gatetowards the flexible rubber seal only at the verge of closure with a view to avoid seal wear and achieve drop tight shut off. The surface of the gate coming in contact with the seal should be polished & buffed.

The bonneted valves shall have glandless design to avoid repeated tightening / replacement of gland packing. The stuffing “O” ring seal should be pressurized by thrust washer from both the sides and should be pressurized / tighten by thrust retainer nut.

The packings should be of graphited synthetic yarn to reduce the friction and offer higher life. Provision shallbe made toenable tightenthe gland packingby means of a pusherarrangement to minimize the leakage through the back of the valve. Replacement of gland packings should be possible in installed condition of the valve without there being line pressure.

The spindle should be double start / single threaded and non-rising type for compact & safe operation. Gate opening indicating arrangement should be provided to find out the extent of gate opening /closing. The operation of the valves shall be manual / motorized as specified elsewhere in the tender specification.

In case the valve is to be operated from a far then it shall be provided with joining couplings, extension spindle, spindle guides and mounting pedestal with suitable anchor bolts / anchor fasteners on the platform.

Materialsof construction:

Thematerialofconstructionforvariouscomponentsofvalvesshallbeasunder.

Body	:DuctileIronIS1865Gr.500/7or 420/12
SealRetainerring	:StainlesssteeltoASTMA-351GradeCF8
InletSeal/RubberSeals/O rings	:FoodGradeEPDMRubber
Knifegate	:StainlessSteelASTMA240type304
Spindle	:StainlessSteelASTMA276type304
Assemblybolts,nutsandfastener	:StainlessSteelASTMA276type 304/316
Spindlenut	:Gunmetal/PhosphorBronze/Brass
Bracket/Adapterplate	:MildSteeltoIS:2062gradeA,EpoxyPainted
Packing	:Graphitedsyntheticyarn

Sr. No.	Description	Particulars		
		IndividualDelivery Line	**Pumping/ Rising Main**	**DewateringPump delivery line**
(a)	Size(mm)	400	600	100
(b)	Quantity	4	1	3
(c)	PressureRating(bar)	10	10	10
(d)	Typeof operation	Motorized	Motorized	Manual

Non-Return Valve

(a) TypeofValve:

- For Raw Sewage & Sludge Application: Only Swing type non return valve complying to IS 5312 Part – 1 & 2 is accepted for the individual delivery line & Common header of the pump. Swing door valves of size 600mm and above shall be of Multidoor type.

(b) The valvesshallbesuitablefor mountingona horizontalpipelineandflowdirectionshall beclearly embossed on the valve body. Hydraulic passages and doors shall be designed to avoid cavitation.

(c) Valvesshallpossesshighspeedclosingcharacteristicsandtobedesignedform inimumslam condition when closing.

(d) Valveofdiametergreaterthan450mmshallbeprovided,inadditiontoothers ,supporting feet and jackingscrews.Hinge pins / shaft shall preferablybe square insection toensure positive location of flaps and provide for secure fixing.

Thematerialofconstructionofvalveshallbeas follows:

S. No	Component	Material
1.	BodyandDoors/ withhinge and diaphragm	SGIronIS1865Gr.500/7/GGG50or400/15/GGG40
2.	Hingepin/Shaft	StainlessSteel;ASTMA276Gr.431/420
3.	Seat/ Face rings	StainlessSteel;ASTMA743CF8M/IntegralNickel-chromium overlay welding and micro finished
4.	BearingsBush	StainlessSteelbackedTeflon
5.	Shaft bearing	BronzeIS318Gr.LTB2
6.	Internal&ExternalFasteners	SS316

Sr. No.	**Description**	**Particulars**			
		IndividualDelivery Line	**Pumping/ RisingMain**	**Dewatering Pump deliveryline**	**Service WaterPump delivery line**
(a)	Size(mm)	400	600	100	40
(b)	Quantity	4	1	3	2
(c)	PressureRating(bar)	10	10	10	10
(d)	InbuiltBypassvalve dia. & Pipe dia.	50	80		

Air Valves

(a) The air valve must be of the type that incorporates a Double orifice kinetic and an automatic air release valve in one unit.It should be able to release air (gases) and to admit air into the sewage line, when the line is emptied. All air valves shall be installed with a resilient seated, glandless design sluice valve for isolation during maintenance.

(b) Theair valve must guarantee complete separation of liquid sewage from thesealingsystemof the air valve under all working conditions.

(c) Theairvalvemusthavearrangementfordrainingandflushingbyexternalwater.

(d) Allsealingmechanismsystempartsoftheairvalveshouldbemadeofstainlesssteel-316.

(e) The body of the valve should be such as to minimise the accumulation of sewage deposit at the bottom of the coating or of cast iron.The valve mechanism must be such as to prevent opening of the air valve upon every slight pressure change in line.

33. Eachairvalvemustbesuppliedwithasluicevaleforisolationformaintenancepurpose.

S. No	Component	Material
(a)	Body/TopCover	DuctileIronGr.GGG-50
(b)	CoverBolts	Austeniticalloysteel
(c)	SeatRing	GunMetal:BS1400LG2/IS318Gr.II
(d)	Float/Balls	SSAISI304

Data:

Sr. No.	Description	Particulars
		AirValvewithIsolationValveatRisingMain
(a)	Size(mm)	150
(b)	Quantity	1
(c)	Rating(bar)	10

SluiceGates&WierGates

(a) DesignRequirementsandConstructionFeatures

Theconstructionofsluicegatesshallbeinaccordancewiththespecificationand generallyas per IS: 13349. All sluice gates shall be of the rising spindle type. All the sluice gates shall be fitted with Portable electric actuators for operation in the plant.

(b) Frame

Theframeshallbeofthe flangebacktypeandshallbemachinedontherearfacetobolt directly to the machined face of the wall thimble.

(c) SeatingFaces

Seating faces shall be made of full width, solid section; dove-tail strips of stainless steel. Theyshallbesecuredfirmlybymeansofcountersunkfixingsinfinisheddove-tailgrooves in the frame and slide faces in such a wayas to ensurethat theywill remain permanentlyin place, free from distortion and loosening during the life of the sluice gates.

(d) WedgingDevices

Sluice gates shall be equipped with adjustable side, top and bottom wedging devices as requiredprovidingcontactbetweentheslideandframefacingwhenthegateisi nclosed position.

(e) LiftingMechanism

(i) Sluicegateshallbeoperatedthroughsuitableliftingmechanismwhichsh all incorporate suitable gearing if required, to keep the torque requirement within 7 kg.m.

(ii) Lifting mechanism shall incorporate a strong locking device suitable for use with apadlock or padlock and chain.

(iii) Liftmechanismshallbeprovidedwithasuitablepositionindicatortoshowthe position of the gate at all times.

(f) WallThimbles

Thecrosssectionofthethimbleshallhavetheshapeoftheletter'F'.

(g) LiftingLugs

Liftinglugsshallbeprovidedforall gates.

(h) FlushBottomSeal

(i) When sluice gates are provided with flush bottom seals, the wedging device and facing along the bottom edge of the slide and frame shall be omitted.

(ii)A solid square cornered, resilientrubbersealshallbe provided on the bottom facing of slide. The seal shall be securely fastened to the bottom face of the slide by a retainer bar and corrosion resistant metal fasteners.The top surface of the bottom facing of frame shall be flush with invert of the gate opening. Bottomfacing of the slide shall be accurately machined to make contact with the seal when the slide is closed.

(i) ThematerialofconstructionofsluiceGateshallbeasfollows:

S. No.	Component	Material
(i)	WallThimble	CastIron:IS210Gr.FG200
(ii)	Frameand Slide	CastIron:IS210Gr.FG200
(iii)	Seatingfaces	StainlessSteel:ASTMCountersunkfixingA276type 316
(iv)	Wedge	StainlessSteel:ASTMA743CF8MorSS316
(v)	Stem	StainlessSteel:ASTMextensionA276type316
(vi)	Stemnut	StainlessSteel:ASTMA743 CF8M
(vii)	StemCoupling	StainlessSteel:ASTMA276type316

S. No.	Component	Material
(viii)	Fasteners,anchor	StainlessSteel:ASTMboltsandnutsA276type316
(ix)	Liftingmechanism,Pedestal gear house cover and stem guide	CastIron:IS210GradeFG 200
(x)	Liftnut	Bronze:ASTMB148(CA952,CA954orCA958)

Data:

Sr. No.	Description	Particulars			
	Location	**Inletand Outletof Coarse Screens**	**OutletofEffluent Chamber**	**Wet well PartitionGate**	**Weirgateat overflow chamber**
(a)	Size(mm) Minimum	1000mmWx 1000 mm H	1000mmWx 1000 mmH	1000mmWx 1000 mm H	1000mmWx 750 mm
(b)	Quantity (Nos.)	4	2	1	1

MechanicalCoarseBarScreen

General

(a) The screen shall be installed in raw sewage inlet channel, and the screen shall be of the front raking type. Inclined Bar screen at 75 degree and the minimum bar thickness shall be 6/ 12 mm.

(b) The screen shall be capable of performing the duties set out in this Specification. All the materials and sub-assemblies used shall be suitable for outdoor application. They shall be constructed so that maintenance is kept to a minimum.

(c) Ideally, any moving parts such as sprocket, bearings, etc should not be in immersed in sewage. In case immersed, the parts shall be of such materials that they require little or no maintenance.All lubricating points shall be conveniently accessible from the deck level.

(d) The screen shall be suitable for discharging 75% of the screened material lifted from the screen into the chute.

(e) Thescreenshallbedesignedsuchthatincaseofheavyaccumulationofsolidsthesameisto be removed gradually without overloading or damaging the screen bars or mechanism.

Framework

The frame work of the screen shall be of robust construction with intermediate cross bracing.The lower ends and sides of the frame shall be grouted in concrete. Each screen shall have an independent canopy at the top for weather protection.

Screenbar assembly

Screen bar assembly shall be fitted across the screen chamber.Screen shall have a series of vertically oriented bars spanning the inlet channel and spaced as specified. Bars shall be sufficiently rigid to prevent vibrations in stream-wise and lateral modes and to withstand the maximum differential head that will occur with the screen totally blinded. Bars shall have tapered cross section to prevent jamming of screenings between bars.Bars shall have supports only at both ends.

Rake carriage

(a) The design shall be multirake and the rake carriages shall comprise a stiffened frame work to which is attached replaceable rake tines. The rake tines shall be suitable to accommodate bulky screenings.Rake carriage shall incorporate suitable devices to enable the rake to ride over any small obstacles wedged in the screen and automatically stop the drive motor in the event of the rake jamming against a large obstruction.There shall not be any mechanical damage resultingfromobstruction wedged inthe screen bars.The rake carriage

shall always come to rest in a parked position with the rake above the sewage level.

(b) The screen shall be cleaned automatically through an adjustable timer. The rake lowered will clear screen bars at the beginning of a cycle and accurately engage with the screen bars at the bottom of the channel.The tine profile and rake motion shall be designed to elevate screenings to the discharge chute at deck level without debris falling back or being forced through the screen. The rake shall be suitable for levating debris encountered at any level. Rake tines shall be replaceable.

(c) The screenings shall be discharged from the unit by a wiper mechanism down to a discharge chute leading to a conveyor belt.Arrangement shall be such as to ensure that screenings are discharged to the discharge chute leading to the conveyor. The rake tines shall then be retracted and the unit ready for the next cycle.

RakeLiftingMechanism

LiftingmechanismshallconsistofaSS316LwireropeorchainandSS316 sprocket.

Inspection Platforms

An inspection platform shall be provided for periodic checking and maintenance of the drive and other critical parts. A ladder with handrails for access to this platform shall be fixed. Suitable hand rails shall be provided for safety on the inspection platform and also at deck level.

Dead plate

SS316Ldeadplateextendingfromthetopofthebarstothedecklevel shallbeprovidedtoensurethat screenings do not fall back. Dead plate shall be made of minimum 5 mm thick plate. The clearance between the tines and the dead plate shall not exceed 5 mm.

Driving Mechanism

The driving mechanism shall consist of a sturdy reduction gear unit driven through multiple'V' belts or directly by an electric motor. Motor shall be mounted in such a way that the tension of the 'V' belts can be adjusted. A manually reset torque limiter shall beprovided between the motor and gear unit, incorporating a limit switch to cut off the supply to motors in the event of an overload.

Gear Reducer

(a) Thereducershallbesizedandselectedwithaminimumservicefactorof2.0time sthemotor nameplate horse power rating in accordance with applicable American Gear Manufacturer's Association Standards.The reducer shall have a life of 40,000 hours based on the motor name plate horse-power. The reducer shall have an efficiency of not less than 90% based on reducer input.

(b) All gear meshes shall be oil lubricated. All gears shall be provided with an oil reservoir for instant lubrication on starting. The gear reducer housing shall be provided with an oil level indicator and oil drain with necessary fittings.

(c) The gear reducer shall be of cast iron construction. The reducer housing shall also include suitable lifting lugs and external gear train inspection covers for each gear train. The gears shall be matched for maximum tolerance variation. The gear reducer shall be suitable to reduce the motor asynchronous speed to achieve the required speed of raking.

Control System

(a) The screening operation shall be carried out through adjustable timers which are adjustableat site for 0-60 minutes for interval between two operations.

(b) Controlsystemfortheconveyorshallbedesignedtoachievethe following:

(i) Conveyorshallbestartedwhenanyoftherakesstartsitsupwardstravel.

(ii) Conveyorshallbestoppedwithatimedelay(byadjustabletimer)afterrakeis stopped.

(c) Weatherproof, lockable, emergency mushroom headed stop push buttons shall be provided near each motor for screen and conveyor belt, operation of stop push button, and overload prevention for screen and belt conveyor shall be included in the control scheme.

Conveyor System

(a) For the disposal of screenings, a common motor driven endless belt conveyor shall be provided.The conveyor shall be designed in accordance with IS11592 or equivalent.The conveyorandchutesshallbesuitableforhandlingoccasionalheavyobjects whichwillcause shock loads.

(b) The construction of the frame and support shall be robust and torque resistant.Belt conveyor shall be of20 deg. trough type complete with drive assembly structures, idlers, pulleys and belt cleaners.Idlersandpulley shall be provided with anti-friction bearings.

(c) The belt material shall be two poly nylon or equivalent with minimum 3 mm neoprene covering on carrying side.Splicing shall be employed to make the belt endless. The belt shall operate over three roll twenty degree, troughing idlers. The idlers shall rotate on precisiontype,deepgroove, singlerowballbearingwithbuilt-inclosefittingtriplelabyrinth grease seal. The ends of the outer shell shall be counter bored and a full length centre tube journalled concentricity. The outer shell, centre tube and precision die formed steel endsshall be brazed into an integral unit to provide concentricity. The ends of the centre tubeshall be bored concentrically with each other after roll assembly to provide correct bearing alignment and to provide prestressing of boring. The centre tube shall be grease fit after assembly.Troughingidlersshallhavemeansofadjustmentorensuringbelttracking.Onthe return run the belt shall operate over flat roll idlers having bearing, shaft and lubrication arrangements asabove forcarryingidlers. Spacingofidlersshallbeof1200 mmon carrying run and 2400 mm on return run.

(d) The head and tail pulleys shall be manufactured from welded steel/any alloy steel and shall be provided with rubber lagging. Laggingfor drive pulleys shall have herringbone grooving. Pulleys shall be equipped with taper lock bushings. The tail pulley shall incorporate a screw rake for adjusting belt tension.Head and tail pulleys shall be adequately guarded.

(e) Shafting for pulleys shall be of heat treated carbon steel. They shall be forged, ground and polished to obtain close diameter tolerances. The head shaft shall be provided with roller bearing pillow blocks.

(f) The belt conveyor shall be driven by a squirrel cage, TEFC motor. A V-belt drive arrangement shall be provided betweenthe motor anda helical speedreducer,thelatter shall

be mounted on the end of the head shaft. The driving pulley shaft shall have back stops toprevent backward movement of the belt.

(g) The conveyor shall be supported on 150mm channel sections with 14 gauge steel deck plate between the two runs of the belt and the necessary supports to the floor.The floor supports shall be made out of steel plates having minimum 6 mm thickness. The conveyor shall be protected from weather by a 'dog box' type canopy.

(h) An adjustable belt scraper shall be provided on the hopper end of the conveyor belt. The scraper and attachments shall be of fibreglass/fibre reinforced plastic.

(i) Screenings discharge chutes shall be providedto transfer screenings fromthe screensto the troughed belt conveyor and from the conveyor discharge to skip.The latter chute shall extend beneath the belt scraper and shall allow access for maintenance of the belt scraper. Chutes shall be designed to minimize the accumulation of rags and stringy materials.

(j) The conveyor shall be fitted with an emergency stop operated by wire rope at foot level.Two Nos. belts way switches shall be provided on conveyor.

Sr. No.	**Description**	**Particulars**
	ScreeningLocation	
(a)	WidthoftheBelt (mm)	Minimum600
(b)	LengthoftheConveyor(m)	Minimum6.0
(c)	Standardof Manufacturing	IS 11592
(d)	Quantity(Nos.)	1 (One)

PortableScreeningsContainer

Portable screenings containers made of galvanized steel shall be provided to

store the screenings until timeofpickup.

Thecontainershallhavecapacityofapproximate2.0cu.mandshallbeofa

convenient height to permit the discharge of screenings directly into the container without having to transfer the screenings manually. The containers shall have hinged covers and their design shallpermit their being lifted by an overhead hoist or packer truck.The container will have four wheels each of about 20 cm diameter and two of which shall be swivel castors. The maximum height of container including wheels shall be 66 cms. The sides shall be constructed of 12 gauge steel. The bottomof container shall be made of 5 mm plate steel.The containers shall be reinforced with 50 mm x 50 mm x 5 mm angle.

Sr. No.	**Description**	**Particulars**
	ScreeningLocation	
(a)	Capacity(Cum)	Minimum 2
(b)	Quantity(Nos.)	Minimum 2
(c)	Materialof Construction	MSFabricated(Galavanised)

AutomaticJamremoval system

ThescreenshallhaveautomaticelectronicallycontrolledJamremoval facilitytoensuresmooth operation.

Motors

(a) Motors shall be squirrel cage type conforming to IS 12615/IS-15999/IS-ICE 60034.The power rating of motor shall be at least 125% of maximum power requirement.The other features of motors shall be as follows:

(i) Typeofduty : Intermittent(S4)
(ii) MethodofStarting : DOL
(iii) Classof insulation : F(TemperatureriselimitedtoclassB)
(iii) Typeof enclosure : TEFC

(iv) Degreeof protection:IP55

(b) ThematerialofconstructionofMechanicalRakedScreenshallbeasfollows:

S. No.	Component	Material
(i)	Screen	StainlesssteelSS316L
(ii)	Frame(SideandBottomPortion)	StainlesssteelSS316L
(iii)	Rakedtines	Stainlesssteel SS316L
(iv)	FastenersincludingAnchorbolts	StainlessSteelSS316L
(v)	Screencanopy	StainlessSteelSS316L
(vi)	Chutes	StainlesssteelSS316L

Sr. No.	Description	Particulars
	ScreeningLocation	IneachScreenChannel
(a)	ChannelWidth(m)	Minimum1.4
(b)	ScreenWidth(m)	Minimum1.1
(c)	ScreeningChannelDepth(m) (Side Water Depth)	Minimum0.7
(d)	Quantity(Nos.)	2Nos.(1W+1S)
(e)	AngleofInclination(degree)	75
(f)	Flowrate(m3/sec)foreachscreen	Minimum0.52
(g)	Bardimension(mm)	12mmx6mmx50mm(front/back/depth)
(h)	BarType	Tapered(Trapezoidal)

Trash Racks

ScopeofSupply

The scope of supply shall include Trash rack system with all accessories and appurtenances,including, but not limited to:

- Removable J-type Trash racks which are installed by lowering the same in side guidechannels or grooves provided in the trash rack channel so that the trash racks may be readily removed by lifting them through guides.

- Lifting Arrangement by one number electric hoist shall be provided for each manually raked screen and the same shall be permanently attached to screen.

- Rakesformanualcleaningafterbringingthemoncleaningarea.

General

One trash racks will be installed before mechanical operated screen, with one working. The structural arrangement of racks generally consists of equally spaced trash rack vertical bars supported on horizontal members connected to end vertical members, which sit in the grooves of guide rail. The trash rack will have J-type structure at the lower end for support and for collection of screened material which will extend for minimum 600 mm from vertical bars. Hook will be provided at the upper end for lifting of the Trash Rack by Electric Hoist. The minimum thickness of the bars will be 12 mm, width 50 mm it should preferably be fabricated from flats with rounded edges. A platform at suitable/finished ground level shall be provided to manually clean the trash rack by raking and by water jetting arrangements for collection of screenings in portable screenings container.

Allthescreensshallbeprovidedwith2setsofSS304cleaningrakeswithappropriategrip handle.

Aperture Size

The screen apertures shall be sized to capture particles of 50 mm and above size. The clear spacing between the bars will be 50 mm.

InclinationofTrashRacks

Rackswillbeinstalledonguiderailswhichwillbekeptinverticalpositionat90 degrees.

Velocitythroughracks

Velocity up to 1.2 m/s at peak flow and 0.6 m/s at average flow on the gross area of racks may be permitted.

RequiredDownstreamWater Level

Contractors should state the maximum and/or minimum allowable water levels downstream of the screen in order to pass the required flow.

TheMaterialof Construction

Thematerialofconstructionofthetrashrackequipmentshallbeingrade316Lstainlesssteel.

ManualRakingandScreeningsRemoval

Suitable arrangement should be made for cleaning the racks manually at regular intervals after removingthe trash rack installed in channel through guide rail. The frequencyof cleaningof the racks would depend upon the rate of accumulation of trash. Not more than 33 percent of the trash rack area should be allowed to clog the racks at any time. The raked screenings will be collected in portable screenings container.

StructuralRequirements

Structural connections in the trash rack should be designed and provided for the failure load of the structural members. All flats should be welded to the intermediate horizontal members and thetopand bottom horizontal members for better resistance to vibrations and to avoid stress concentration at the external edge of the groove. The vertical member of the trash rack should be so arranged as to apply the load near the inner part of the rack guide. The guides of the trash racks should be so proportioned that the side members get lateral support from guides after deflection to take up the clearance in the slots.

Access

Safe access shall be provided to all trash racks when hoisted to allow for cleaning, inspection and maintenance activities.

CorrosionResistance

All metal parts of the screen equipment that are in contact with the sewage shall be constructed of a suitable grade of corrosion resistant stainless steel 316 L.

WorkingStressand Design

The design of all parts shall ensure that under the most onerous of conditions they will not bedamaged or corroded.

Any joint that will need to be dismantled during maintenance shall be made by anti-corrosion type fasteners.

All spareparts shall befullyinterchangeable with theoriginal part. If thespare partis unavailable due to cease of production, the Contractor shall give notice to the Employer in writing, detailing the options available to the Contractor.

All parts shall be designed to minimize the risk of fire and consequential damage. All parts shall be designed to prevent the ingress of vermin, dust and dirt. All electrically live or moving parts shall be adequately guarded to prevent accidental contact.

Sr. No.	**Description**	Particulars
	ScreeningLocation	IneachScreenChannel
(a)	ChannelWidth(m)	Minimum1.4
(b)	ScreeningChannelDepth(m) (Side Water Depth)	Minimum0.70
(c)	Quantity(Nos.)	2Nos.(1W+1S)
(d)	AngleofInclination(degree)	90

(e)	Flowrate(m3/sec)foreachscreen	Minimum0.52
(f)	Bardimension(mm)	12mmx50mm(Width/depth)
(g)	BarType	Rectangular

Hoists

ElectricallyOperatedHoists

(a) Electric hoists shall be complete with hoisting motor, wire rope drum, wire rope, hook, necessary gearing, sheaves, electromagnetic brake for hoisting motion, weather & dust- proof push button station, contractor panel, all wiring, limit switches, etc.

(b) Electric hoists shall conform to IS: 3938 and shall be suitable for outdoor application. All the parts of the hoist shall be designed to withstand surrounding atmospheric conditions without any deterioration. Creep motor arrangement shall be provided for lifting purpose.

(c) Rope drums shall be either cast or welded to sustain concentrated loadsresultingfromrope pull. Drums shall be machine grooved right and left with grooves of a proper shape for the rope used.

(d) Gears shall be cut from solid cast or forged steel blanks or shall be of stress-relievedwelded steel construction or built-up from steel billets and welded together to form a one piece gear section. Hoist ropes shall be extra flexible, improved plough steel rope with a well lubricated hemp core and having six strands of 36 wires per strand with minimum ultimate tensile strength of 1.6 x 106 KN / Sq.m.

(e) Hooksshallbesolid,forged,heattreatedalloyorcarbonsteelofruggedconstr uctionofthe single hook type and provided with a standard depress type safety latch.

(f) Hoisting motor shall be equipped with electrically released, spring set,

friction shoe type brakeshavingtorquecapableofholding125%ofthefullratedhookload.Brake shall

apply when either the motor controller or the main power switch is in 'OFF' position or in the event of power failure.

(g) Drive motors shall be designed for frequent reversal, braking and acceleration and shall be as per IS:12615/IS 15999/IS-IEC 60034. Pendant control switch, controllers and resistors, controls, electrical protective devices, cables and conductors, earthing guards etc. shall be as per IS:3938. Limit switches shall be provided for over-hoisting and over-lowering.

(h) TheelectrichoistsshallbeofClassIIduty.

(i) 25% overload test, speed tests, limit switch tests and brake test shall be conducted for the hoist and trolley at manufacturer's works.

(j) Necessary number (2 sets) and capacity of slings and Deshackles shall be supplied to the plant for the operation.

Sr. No.	**Description**	**Particulars**	
	Location	**ISPSWetwell**	**InScreenChannel for Screen lifting**
(a)	Capacity(Ton)	Minimum5.0	Minimum2.0
(b)	CrossTraverse(m)	Minimum12.0	Minimum6.0
(c)	HeightofLift(m)	Minimum14.0	Minimum9.0
(d)	CrossTraverseSpeed (m/min)	6.0	6.0
(e)	Lift/HoistSpeed(m/min)	3.0	3.0
(f)	CreepSpeed(m/min)	1.0	1.0
(g)	Quantity(Nos.)	1.0	1.0

HandOperatedHoistsand Trolleys

(a) Manual hoists shall be complete withhand-chain, trolley, pulley block, hook, hand and load chains, brake and other accessories. They shall comply with the latest applicable standards, regulations and safety codesin the locality where equipmentwillbeinstalled.

(b) Each hoist shall be operated on a monorail (I-Beam).The factor of safety shall not be less than 5.The load chain may be heat-treated to give ductility, toughness and conforming to I.S.3109/B.S.1663/B.S.3114.The load wheel is to be made from heavy duty malleable castings.The hand chain is to Conform with B.S.6405:1984 and hand chain wheel may be made from pressed sheet steel with roller type guarding.Gears shall be cut from solid cast or forged steel blanks or shall be stress – relieved welded steel construction.

(c) Pinionsshallbeofforgedcarbonorheattreatedalloysteel.Strength,QualityofSteel,heat treatment, face, pitch of teeth and design shall confirm to BS-436, BS-545 and BS-721. Spur and helical gears must comply with B.S. 436 and wormwith B.S.721.Bearing must be ball and roller type conforming to I.S. 2513/B.S., 2525-32:1954.

(d) Proper lubricatingarrangements are to be provided for bearings and pinions.The brake for the lifting gear shall be automatic and always in action.

(e) The proof testing of each chain pulley block is to be carried out as per latest applicable standards.The safe working load is to be marked in such way that is clearly visible from the operating level.

DomesticWaterPump sets

Centrifugal Monoblock Pump set, self priming monoblock pumpset with suitable for pumping clear water from sump to the overhead tank shall be provided, conforming to IS 9079 operating at 2900 RPM with pump casing: Cast Iron IS 210 FG Gr.260, Impeller: Bronze IS 318 LTB2, Shaft: SS 410, Pump Seal: Mechanical Seal, priming funnel, cock, suitable flanges at suction and delivery side.Pump shall have common shaft for pump and motor. Pump Capacity of

minimum 5 cu.m/hr and atotal head of minimum 20 m. Motor shall be suitable for working on 415 V +/- 10%, 3 Ph, 50Hz +/- 5%A.C. Supply. Motor shall be TEFC type. Pump set shall be suitable for working at various dischargeandheadrequirements.PumpshallbeerectedonProvidedC.C.foundationblockwith

suitable foundation bolts grouted in C.C foundation block. Pressure Gauge shall be installed on the delivery line.
Pumpsets connected to a common header of 40 NB size of suitable length, 40 NB suction and discharge piping with necessary unions, bends and tees shall be provided.Suction and discharge isolation valve and non-return valve on the discharge side shall be forged steel/ Brass valve.Piping shall be as per IS: 1239 heavy class. Minimum one number 2000 litres capacity shall be installed on one at Adminstrative Building and one at LT Switch Gear Room, Polyethylene water storage tanks withmanholelidandsuitablelockingarrangements,makingholesofsuitablediameter forinlet,outlet and overflow pipes.

Sr. No.	**Description**	Particulars
	ServiceWaterNetworksystem	
(a)	ISPSCampus	2Nos.(1W+1S)

FireExtinguishers

(a) Portable fire extinguishers are to be provided for all units as per the requirement of Tariff Advisory Committee (TAC) or meeting the requirement of local regulations whichever is stringent. CO2 type-squeeze Grip fire extinguisher 2 Kg capacity with initial charges with wall mounting bracket, ready for use (TS 2678).

(b) AlltheextinguishersshallbeofTACapproved.

Sr. No.	Description	Particulars
(a)	Capacity(Kgs.)	Minimum2.0
(b)	Quantity(Nos.)	Minimum3.0

PropellerExhaustFan

(a) ThefanshouldcomplywithIS 2312.

(b) The blades shall be of mild steel and properly balanced so as to avoid noise and vibration.The blade and blade carriers shall be securely fixed so that they do not loosen in operation. The means provided for securing the fan mounting or fan casing to the wall partition or window shall be such as to provide a secure fixing without damage to the fan or wall.

(c) Suitably designed guards shall be fitted to the inlet and the outlet side to prevent accidental contact. No flammable material shall be used in the construction of fan. Moulded parts, if used, shall be of such materials as to withstand the maximum temperature attained in the adjacent component parts.

(d) The fan shall have protective insulation or be capable of being earthed.A fan with protective insulation may be of all insulated construction or have either double insulation or reinforced insulation.Each fan should be provided with a 10 sq.mm mesh bird screen.The sheet used for the cowl should be 14 G.

(e) HeavyDutyExhaust Fans with bracket blades and Bird cowl arrangement Group "A" Dia. = Minimum 15" sweep (450 mm) with 1440 RPM, 230V,50Hz, AC supply to provide 10-12 air changes per hour.

Sr. No.	**Description**	**Particulars**
(a)	Quantity(Nos.)	Minimum8 (Eight)

Forced FreshAirCirculationSystem

Fresh air circulation system is to be provided for the pump house for circulation of fresh air to limit increase in temperature and also avoid stale air presence. The complete system along with all associated required air supply fans, exhaust fans, ducts, grills, galvanized bird screens, hoods and all necessary accessories shall be provided. Suitable arrangements to prevent ingress of rain water into building shall also be provided. The system shall be designed with required air

changes and the contractor shall provide detailed calculations to determine the air capacity, static pressure etc. and relevant technical details for the approval of Engineer.

Allductworkshallbeofhighqualityapprovedgalvanizedsheetsteelguaranteednottocrackorpeel on bending of fabrication of ducts.

The ducts shall be fabricated from galvanized plain steel sheets conforming to IS: 277-2003. All duct work,sheetmetalthicknessandfabrication,unlessotherwisedirected,shallstrictlymeetrequirements as described in IS: 655.

All joints shall be tight and shall be made in the direction of air flow. The ducts shall be reinforcedwhere necessary and must be secured in place so as to avoid vibrations of the duct and its supports.

Volumecontroldampersshallbeofanapprovedtype,leveroperatedandcompletewith locking devices which will permit the dampers to be adjusted and locked in any position.

Exhaustfansofappropriateratingshallbeprovidedforpumpingstations.Thecontractorshallsubmit the fan selection details for approval.

Foraxialflowfans/propellerfans,speedlimitationshallbeas follows:

Forimpellerdiameterofup-to450mm– maximumspeedshallbe1500 rpm.

Forimpellerdiameterabove450mm–maximumspeedshallbe1000 rpm.

Suitabledesignedguardsshallbefittedtotheinletandtheoutletsidestopreventaccidentalcontacts. No inflammable material shall be used in the construction of fans.

Drive motors shall be rated at least 15% higher than the power requirement at duty point or 10% higher than the maximum power requirements at the selected speed, whichever is higher. Motor shall be conforming to TEFC, IP 54

protection.

Air-conditioning Equipment

The air-conditioning units shall be ceiling suspended.Both the units shall be located above the false ceiling provided in the control room.Ducting shall run continuously from the units with suitable collars at regular intervals for the outlet to supply air diffusers.Return air shall be taken through 50 mm slit provided between the false ceiling and the side wall. Fresh air opening of size 250 mm x 200 mm on the side wall of the room above the false ceiling with wall cowl, bird screen and damper shall be provided.Outdoor condensing unit shall be mounted on the terrace of the room or grouted on external side of the wall with suitable brackets. Air conditioners suitable for operation on A/C supplysingle Ph 50 Hz 230 Volts with hermetically sealed conformer with air cooled condensor, motor capacitor start run capacitors relay and overload protector internal unit with one indoor and one outdoor unit.

Sr. No.	**Description**	Particulars
(a)	Capacity(TR)	Minimum2.0
(b)	Quantity(Nos.)	Minimum2.0

(i) Tool Kit

Thebiddershallsupplytheminimumnumbersof Tools&tacklesasdefinedinthebelow table.

Sr. No.	**Description**	**Quantity (Nos.)**
i	Doubleendspannerset 6to32Jhalani make	1
ii	200mmScrewdriver825Tapariamake	1
iii	300mmScrewdriver829Tapariamake	1
iv	200mmCuttingplierTapariamake	1
v	800gmBallPenHammerwithhandle -Tapariamake	1
vi	Pipewrench14"Jhalani make	1

Sr. No.	Description	Quantity (Nos.)
vii	Pipewrench24"Jhalani make	1
viii	LevertypeGreasegun	1
ix	Ringspannerset6to32Jhalani make	1
x	12"BearingPuller	1
xi	Tool boxfabricatedfromMSsheetof18SWGofsize50cmx 30 cm x 30 cm with locking arrangement	1
xii	DigitalTongTesterCEmakeorequivalent	1
xiii	DigitalMultiMeterCEmakeor equivalent	1

AirHose Apparatus

It shall consist of full vision face mask with inhalation and exhalation valve, connected to acorrugated tube ending in a manifold non-return valve, mounted on a harness belt worn around the waist, tested to BS 1397.The 50m long, 20mm canvas reinforced wire embedded hose, connected to the manifold shall be uncrushable and shall not kink.

The radial blower connected to the hose shall be housed in a strong carrying box which can hold the breathing apparatus with hose and fittings.The blower shall be suitable for supplying air to two people simultaneously.

Note: Any equipment capacity and quantity specified in the document shall be treated as minimum requirements of the Employer.

ApprovedVendor/Manufacturer/MakeList-Mechanical Equipment

S.NO.	ITEMDESCRIPTION	APPROVED VENDOR/ MANUFACTURER/MAKE
1	Cranes(EOT,Hoists,Jib cranes)	M/sW.H.Brady
		M/sTranspade Engineers
		M/sSafex Electromech
2	HorizontalCentrifugalPumps	M/sKBL
		M/sGrundfos
		M/sWilo
		M/sKSB
	SubmersiblePumps	M/sKSB
		M/sXylem
		M/sWilo
		M/sABS Sulzer
		M/sGrundfos
		M/sKishor
3	Sluice/ GateValve,NonReturnValve&AirValve	M/sVAG
		M/sKBL
		M/sAVK
4	PenstockGates	M/sJash
		M/sYashwant
5	DI/GIpipes	M/sKejriwal Castings
		M/sElectrosteel
		M/sSurya Pipes
		M/sJindalPipes
6	DIFittings	M/sKiswok
		M/sElectrosteel
		M/sJindalFittings

	CONSOLIDATEDMechanicalEquipmentVENDORLIST	
S.NO.	ITEMDESCRIPTION	APPROVED VENDOR/ MANUFACTURER/MA KE
		M/sKejriwal Castings
7	Weir Gates	M/sJash Engineering
8	MechanicalScreens(Bar type)	M/sJash Engineering
		M/sJohnson screens
		M/sHeadworks
		M/sHuber
9	ElectricActuators	M/sAuma
		M/sLimitork
		M/sRotork
10	UPVC&HDPEPipes	M/sJain Irrigation
		M/sFinloex
		M/sDuraline
		M/sManikyaPlastichem
		M/sPennwaltAgro
		M/sSupreme
11	Motors	M/sCromptonGreavesLtd
		M/ sMarathonElectric(Alstom)
		M/ sKirloskarElectriccompany
		M/sBharatBijleeLtd
		M/sABB
12	BallValves	M/sBDK Engineers
		M/sFlowchem
		M/sVirgo
		M/sKBL

	CONSOLIDATEDMechanicalEquipmentVENDORLIST	
S.NO.	ITEMDESCRIPTION	APPROVED VENDOR/ MANUFACTURER/MA KE
		M/sMicrofinish
13	KnifeGate valves	M/ sJashEngineering(Scheute)
		M/sBray
		M/sFouress
		M/sVAG
		M/sKBL
		M/sOrbinox
14	Airconditioner	M/sBluestar
		M/sVoltas

All the equipment, to be supplied under this contract have to be from experienced manufacturer. The equipment of only those manufacturers, who have sufficient proven experience of manufacturing the respective equipment of similar capacity, shall be considered. The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers fromoffering equipment.Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer'sservice,likeitemsofequipmentprovidedhereundershallbetheendproductsofone
(1) manufacturer.

Intheeventthatthecontractorwishestoproposealternatemakesfortheequipmentmentionedabove, he shall submit the following:

1. Demonstratethattheproposedmakesare“Superior/Equivalent”totheapprovedmakes.
2. Manufacturer involved in manufacture of specified equipment for at

least 5 years before bid date

3. At least 5 successful installations commissioned in last 3 years before bid date and satisfactorily operating for at least one year before bid date. End user certificate shall be provided for the same.

Manufacturer to provide full contact information for each reference as part of technical bidAnd the abovequalitiesandrequirementsshallbedemonstratedandevidenced byinspectionofmanufacturing units and successfully installed plants (at the End users plant/premises) for the equipment's desired and successful operation and certification by the Employer/Engineer (BWSSB)/Representative.

TheEmployershallreservetherighttoacceptorrejecttheBidderproposedmakesof Equipment.

Warranty

A. Comply with the requirements of each type of Equipment and specification mentioned elsewhere in this document.

B. Warrant all components to be free of defects in materials or workmanship for 12 months from date of satisfactory completion of performance test.

C. Individual warranties by component manufacturer in lieu of single source responsibilityby the main Equipment manufacturer shall not be acceptable.

D. Items which fail during the warranty period, excluding expendable items, shall bereplaced without cost to the Owner.

E. Providemanufacturer'sguaranteeandwarrantycertificatespriortoequipmentstart-up.

Pipelines,PipeworkandFittings

Applicablecodes

Thefollowingcodesandstandardsunlessspecifiedhereinshallbereferredto,orequiva

lenttothe approval of Engineer.

Materials

IS: 210	Specificationforgreyironcasting
IS: 290	Specificationforcoaltarblackpaint
IS: 456	Codeofpracticeforplainandreinforced concrete
IS: 458	Specificationforprecastconcretepipes(withandwithoutreinforcement)
IS: 516	Methodoftestforstrengthofconcrete
IS: 638	Specificationforsheetrubberjointingandrubberinsertionjointing
IS: 783	Codeofpracticeforlayingofconcretepipes
IS: 816	Code of practice for use of metal arc welding for general construction in mild steel
IS: 1367	Technicalsupplyconditionsforthreadedsteelfasteners
IS: 1387	Generalrequirementsforthesupplyofmetallurgicalmaterials
IS: 1500	MethodforBrinellhardnesstestformetallicmaterials
IS: 1536	Specificationforcentrifugallycast(spun)ironpressurepipesforwater,gas and sewage
IS: 1537	Specificationforverticallycast-ironpressurepipesforwater,gasandsewage
IS: 1538	Specificationforcastironfittingsforpressurepipesforwater,gasandsewage
IS: 1916	Specificationforsteelcylinderpipeswithconcretelining andcoating
IS: 2078	Methodfortensiletestingofgreycastiron
IS: 3597	Methodoftestsforconcretepipes
IS: 3658	Codeofpracticeforliquidpenetrantflowdetection
IS: 5382	Specificationforrubbersealingringsforgasmains,watermainsandsewers
IS: 5504	Specificationforspiralweldedpipes
IS: 6587	Specificationforspunhempyarn
IS: 7322	Specificationforspecialsforsteelcylinderreinforcedconcretepipes

Code of Practice

IS: 783 Codeofpracticeforlayingofconcretepipes

IS: 3114 Codeofpracticeforlayingofcastironpipes

IS: 3764 Excavationwork-CodeofSafety

IS: 4127 Codeofpracticeforlayingofglazedstonewarepipes

IS: 5822 Codeofpracticeforlayingofelectricallyweldedsteelpipesforwatersupply.

IS: 6530 Codeofpracticeforlayingofasbestoscementpressurepipes.

Materialsfor Pipelines

Each pipeline shall be constructed in a material compatible with the fluid conveyed through that pipeline, i.e. the materials used in the pipes which are or can be in contact with the untreated ortreated sewage, shall not contain any matter which could impart taste or odor or toxicity or otherwise be harmful to health or adversely affect the sewage conveyed. Nor shall any pipe be adverselyaffected by the fluid being conveyed through that pipe.

Pipe work and valve materials for the following duties shall be as follows or equivalent to theapproval of the Engineer:

TABLE11.1.....PIPEWORKANDVALVE MATERIALS

Application/Location	Material
Water: RawSewage,Dewateringsludge	Mild steel with mortar lining/guniting (Beyond1100mm diameter of pipe) and Ductile iron K9 (Up to 1100mm).
Servicewater	GI(below80mm)HeavyDutyclass,DuctileironK9 (80mm and above).

All pipes, fittings, bolts, nuts, jointing materials and appurtenances for piping to be requiredforexecutionoftheWorksshallbemanufacturedanderectedinaccordancewith the erection plans, specifications and directives of the Engineer.All pipe work and fittingsshallbetoaclass inexcessofthemaximumpressureattainedinserviceincluding any surge pressure.

Thepipeworkinstallationshallbesoarrangedtoofferеaseofdismantlingand removalof pumps or other major items of equipment.Ductile Iron dismantling joint shall be included in the suction and delivery pipe work of all pumps as well as on delivery header for easy dismantling, and provision shall be made for a flexible joint arrangement to buildingstructures.Allllooseflangesshallbesecuredtofixedflangesbysuitabletie-bolts.

All pipe work shall be adequately supported with purpose-made fittings. When passing throughwalls,pipeworkshallincorporateapuddleflangeorothersuitablesealingdevice.

Flange adapters and unions shall be supplied and fitted in pipe work runs, wherever necessary,topermitthesimpledisconnectionofflanges,valvesandequipment.Thefinal outlet connection of the pipe work shall match the connecting point of the transmission main.

Flangedjointsshallbemadewithminimum3mmthickfullface,fabricreinforcedrubber or non-asbestos gaskets, pierced to take the bolts, and the face of all flanges shall be machinedto giveatrueangleof90°tothecenterlineofthepipe orfittings. Allnecessary supports,saddles,slings, fixingboltsandfoundationboltsshallbesuppliedtosupportthe pipe work and its associated equipment in an approved manner. Valves, meters and other devices mounted in the pipe work shall be supported independentlyof the pipes to which they are connected. The bolts shall be equality tighten in comply with international standard approved by the Engineer.

The whole of the jointing work and materials necessary to fix and connect the pipes, including adequate and efficient pipe support shall be included in the Contract. The Contractor shall be responsible for ensuring that the internal surface of all pipe work is thoroughly clean before and during erection and before commissioning. Cleaning shall include removal of all dirt, rust, scale and welding slag due to Site welding.Before dispatchfromthemanufacturer’sworks,theends ofthepipes,branchpipes,etc.,shallbe suitably capped and covered to prevent any accumulation of dirt or damage. This protection shall not be removed until immediately prior to connecting adjacent pipes, valves orpumps. All small borepipes shall beblown through with compressed air before connection is made to instruments and other equipment. No point of passage of pipes throughfloorsorwallsshallbeusedasapointofsupport,exceptwiththeappr ovalofthe Engineer.

Material of steel pipes and fittings shall conform to IS: 2062.ERW/Spirally welded MS pipes(Fe-410grade)FabricationandtestingshallbeinaccordancewithIS:3589forpip es and IS: 6392, ISO 7005 or BS EN 1092 for flanges.Minimum corrosion allowance shall be 2mm.

HydraulictestasperIS3589-2001withlatestamendmentsfortestpressureandworking pressure both at factory and site etc., complete as per detailed specifications. with inside CM 1:1.5 lining of minimum 10 mm thick upto 610 mm OD & minimum 12 mm thick beyond 610 mm OD and outside minimum 25 mm thick coating in CM 1:3 over 50 x 50 mm weld mesh of 13 gauge. Pumping Main shall be of 1600 mm inner diameter and Overflow pipe shall be 1400 mm.

AlltheBypasspipingforthevalvesshallbeofSS316Schedule80Swithallnece ssary flanges and fittings.

Thethickness ofthe pipes shallnot beless than thevalues indicated below:

PipeSize	MinimumThickness(mm

NB(mm)	)
150	8
200	8
300	8
350	8
400	8
450	8
500	8
600	10
700	10
800	10
900	10
1000	10
1200	12
1300	12
1400	14
1500	14
1600	16

DuctileIron PipesandFittings

PipesandFittings

(a) General

Ductile iron pressure pipes and fittings (Class K9) shall comply with IS 8329 and IS 9523. All fittings shall be socketed unless specified otherwise.

(b) Materials

Thematerialsusedinthemanufacturepipesandfittingsshallcomplywith IS8329andIS 9523.

(c) Tests

Testson pipes andfittings shall becarriedoutinaccordance with IS8329 and IS9523. The test method shall be submitted for approval of Engineer.

TheEngineershallbepermittedfreeaccesstotheplaceofmanufactureforthepurposeof examining, inspection and witnessing the testing of pipes and fittings.

Joints

(a) SpigotandSocket Joints

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS :5382-1969 (Latest edition/revision with amendments, if any)).

(b) Flanged Joints

These shall comply with dimensions and drilling details shall be to BS EN 1092-1/BS: 4504 Table10/11 and16/11.All flanged joints between steel and ductile iron pipe work shall be electrically isolated joints. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts. All materials shall be supplied by aspecialist manufacturer and be to the approval of the Engineer.

Linings

Ductile iron pipes and fittings shall have a cement mortar lining, in accordance with IS 11906 or ISO 4179.

Pipeliningsshallbeinspectedonsiteandanydamage ordefectiveareasmadegoodtothesatisfaction of the Engineer. The Contractor may use specialist mortars, mortar additives or curing agents only with the approval of the Engineer.

Certainsectionsareamplifiedasfollows:

No additives shall be used without the written approval of the Engineer, and shall be used strictly in accordance with the manufacturer’s recommendations.

Theminimumthicknessoftheliningat onepointshallnotbelessthan4mm.

Coating

(a) General

Ductile iron pipes and fittings shall be zinc coated with bitumen over coating, all in accordance with the following Specifications. Buried pipes and fittings shall also have a site or factory applied polythene sleeving. Pipe coatings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Engineer.

(b) ZincCoating

Zinc coatingshallcomplywith ISO8179andshallbeapplied asa spraycoating.Themass of sprayed metal shall not be less than 130 g/m^2 as described in Clause 5.2 of ISO 8179.

(c) BitumenCoating

Bitumen coating shall be of normal thickness 0.07 mm unless otherwise specified.It shall be a cold applied compound complying with the requirements of BS 3416 Type II, suitable for tropicalclimates, factory applied in accordance with the manufacturer's instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

(d) PolytheneSleeving

Where polythene sleeving is specified (generally for all buried DI pipes need sleeve covering) to be applied in addition to bitumen coating it shall comply with ISO 8180. Site applied sleeving shall be stored under cover, out of direct sunlight, and its exposure to sunlight shall be kept to a minimum. Pipes having a factory applied sleeving must be stored in the same conditions.

ReinforcedCementConcretePipes

DesignofRCCpipesincludingreinforcementdetailsandtheendsofpipesshallbein

accordance with the relevant clauses of IS: 458.

General

The method of manufacture shall be such that the form and the dimensions of the finished pipes are accurate within the limits specified in relevant clause of IS: 458. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis. The ends ofthe pipes shall be further reinforced by an extra ring of reinforcement to avoid breakage during transportation.

TheRCCpipesandcollars/ rubberringsshallbesystematicallycheckedforanymanufacturingdefects by experienced supervisors so as to maintain a high standard of quality.

The Engineer shall at all reasonable times have free access to the place where the pipes and collars/rubber rings are manufactured for the purpose of examining and testing the pipes and collars/ rubber rings and of witnessing the test and manufacturing.

All tests specified either in this Employer's Requirements or in the relevant Indian standards shall be performed by the supplier/contractor at his own cost and in presence of the Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to the Engineer.

If the test is found unsatisfactory, the Engineer may reject any or all pipes of that lot. The decision of the Engineer in this matter shall be final and binding on Contractor and not subject to any arbitration or appeal.

Materials

For all materials Factory's test result, and written guarantee document with necessary analysis data shall be submitted to obtain the approval of the Engineer before carrying to sites.

Cement

Cement used for the manufacture of RCC pipes and collars shall conform to relevant IS codes. Theuse of pozzolana as an admixture to Portland cement shall not be permitted.

Aggregates

Aggregates used for the manufacture of RCC pipes and collars shall conform to IS: 383. The maximumsize ofaggregate should notexceedonethird the thickness ofthepipeor 20mm, whichever is smaller.

MixingandCuringWater

Water shall be clean, colour less and free fromobjectionable quantities of organic matter, alkali, acid, salts, or other impurities that might reduce the strength, durability or other desirable qualities of concrete and mortar. Contractor shall submit water quality report before using it.

Reinforcement

Reinforcement used for the manufacture of the RCC pipes and collars shall be mild steel Grade I or medium tensile steel bars conforming to IS:432 (Part-1) or hard-drawn steel wire conforming to IS: 432 (part-2). Reinforcement cagesfor pipes and collarsshall beas perrelevantrequirement of IS:458.

Concrete

Concrete used for the manufacture of RCC pipes and collars shall conform to IS: 456. The minimum cement content and minimum compressive strength of concrete shall be as per relevant requirements of IS: 458. Compressive strength tests shall be conducted on 15 cm cubes in accordance with the relevant requirements of IS: 456 and IS: 516.

Curing

Pipes manufactured in compliance with IS: 458 shall be either water cured or steam cured in accordance with the relevant requirements of IS: 458.

Dimensions

The internal diameter, wall thickness and length of barrel and collar of pipes, reinforcement (longitudinal and spiral), type of ends and minimum clear cover to reinforcement andstrength test requirements shall be as per the relevant clauses / tables of IS:458 for different classes of pipes.

Thetolerancesregardingoveralllength,internaldiameterofpipesorsocketsandbarrelwallthickness shall be as per relevant clause of IS: 458.

Workmanshipand Finish

Pipes shall be straight and free from cracks. The ends of the pipes shall be squarewith their longitudinal axis so that when placed in a straight line in the trench no opening between ends in contact shall exceed 3 mm in pipes upto 600mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter.

The outside and inside surfaces of the pipes shall be smooth, dense and hard, and shall not be coated with cement wash or other preparation unless otherwise agreed to between the Engineer and the manufacturer or supplier.

The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or moulding.

The pipes shall be free from local dents or bulges greater than 3 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.

The deviation from straight in any pipe throughout its effective length, tested by means of rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed, for all diameters 3 mm for every meter run.

Testing

All pipesfor testing purposes shall be selected at random from the stock of the manufacturer andshall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS: 458.Engineer reserve the right to attend all testing.

During manufacture, tests on concrete shall be carried out as per IS: 456. The manufacturer shall supply, when required to do so by the Engineer the results of compressive tests of concrete cubes and split tensile tests of concrete cylinders made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the Engineer and such cylinders or cubes shall withstand the tests prescribed as per IS:458. Every pressure pipe shall be tested by the manufacturer for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.

The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 458 and tests in accordance with the methods described in IS: 3597.

i) Hydrostatictest

ii) Threeedgebearing test

iii) Absorptiontest

iv) Visual Examination

Samplingand Inspection

In anyconsignment, allthepipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformityof a lot to the requirements of this Employer’s Requirements shall be ascertained on the basis of tests on pipes selected from it.

The number of pipesto be selected fromthe lot fortestingshall be in accordance withTable 15 of IS: 458.

Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in aserialorderand startingfromanypipe,everypipe be selectedtillthe requisitenumber is obtained, or being the integral part ofN/nwhere N is the lot size and n is the sample size.

All pipes selected shall be inspected by Engineer for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

The number of pipes to be tested shall be in accordance with column 4 of Table 15 of IS:458. These pipes shall be selected from pipes that have satisfied the requirements mentioned in the above clause.

A lot shall be considered as conforming to the requirements of IS:458 if the following conditions are satisfied.

The number of defective pipes shall not be more than the permissible number given in column 3 of Table 15 of IS: 458.

Allthepipestestedforvarioustestsshallsatisfycorrespondingrequirementsofthetests.

In case the number of pipes not satisfying requirements of any one or more tests, one or two further samples of same size shall be selected and tested forthe test ortestsin which thefailure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

Allresultoftesteddatamustbepreparedbycontractoratsitesothatthe Engineershallmakedecision of “fail or pass” at once. All cost for the test shall be borne by the Contractor.

Marking

Thefollowinginformationshallbeclearlymarkedoneach pipe:

a) InternalandExternaldiameterandlengthofpipe

b) Classof pipe

c) Dateofmanufactureand

d) Nameofmanufacturerorhisregisteredtrade-markorboth.

Jointing

General

Jointing of RCC pipes shall be done as per the requirements of following Employer’s Requirements and as per the relevant IS standard. After jointing, extraneous material, if any, shall be removed from the inside of the pipe and the newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS: 5382. The pipe joint work must be done neatly and keep even slope and level for pipe laying works.

SpigotandSocketjoint (Rigid)

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The opening of the joint shall be filled with stiff mixture of cement mortar which shall be rammed with caulking tool. This joint is used for low pressure pipe line.

Collar Joint (Rigid)

After laying the RCC pipes at proper alignment and gradient their abutting faces shall be coated with hot bitumen in liquid condition by means of a brush. The wedge-shaped groove in the end of the pipe shall then be filled with a tarred gasket in one length for each joint. The collar shall then be slipped over the end of the pipe and the next pipe butted well against the tarred gasket by suitable appliances approved by the Engineer so as to thoroughly compress the tarred gasket into thegrooves, care being taken that the concentricity of the pipes and levels are not disturbed during this operation.

Thecollar shall then be place symmetricallyover theend of the two pipes andthe space betweenthe inside of the collar and the outside of the pipe filled with a mixture of cement and sand to withstand any stress and prevent any water leakage, tempered with just sufficient water to have a consistency of the semi-dry conditions, well packed and thoroughly rammed with caulking tools. The joints shall be finished off with a fillet sloping at $45^0$to the side of the pipe. The finished joints shall be protected and cured thoroughly as directed by the Engineer. Any plastic solution or cement mortar that mayhave been squeezed into the inside of the pipe shall be removed so as to leave the inside of the pipe perfectly clean.

FlushJoint (Internal)

This joint shall be generally used for culvert pipes of 900 mm diameter and over. The ends of thepipes are specially shaped to form a self centering joint with an internal jointing space 13 mm wide. The finished joint is flush with both inside and outside with the pipe wall. The jointing space is filled withcement mortar
mixedsufficientlydrytoremaininpositionwhenforcedwithatrowelorrammer.

FlushJoint (External)

This joint is suitable for pipes which are too small for jointing from inside. This joint is composed of specially shaped pipe ends. Each end shall be butted against each other and adjusted in correct position.The jointing space shall then be filled with cement mortar sufficiently dry and finished off

flush. Greatcareshallbetaken to ensurethat the projectingendsarenot damaged as no repairs can be readily affected from inside the pipe.

SpigotandSocket(Semi-flexible)

This joint is composed of specially shaped spigot and socket ends on the RCC pipes. A rubber ring shall be lubricated and thenplaced on the spigot whichis forcedintothe socket ofthe pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the twosurfaces of the spigot and socket, stiff mixture of cement and mortar shall then be filled into the remaining annular space with a caulking tool.

CollarJoint(Semi-Flexible)

Thisjoint is made up of aloose collar whichcoverstwo speciallyshaped pipe ends. Each endshall be fitted with a rubber ring which when compressed between the spigot and collar, seals the joint. Stiff mixture of cement mortar shall then be filled to withstand stress and prevent any water leakage, into the remaining annular space and rammed with a caulking tool.

SpigotandSocketJoint (Flexible)

TheRCC pipewith the rubber ringaccuratelypositioned onthespigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The RCC pipes shall be of spigot and socket type and rubber rings shall be used, and the manufacturer’sinstructions shall be deemed toforma partoftheseEmployer’s Requirements. Therubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

CleaningofPipes

As soonas astretch of RCC pipeshasbeen laidcomplete from manholeto manhole

or for astretchas directedbytheEngineer,Contractorshallrunthroughthepipesbothbackwardsandforwardsa

doubledisc or solid or closed cylinder75 mmlessin diameterthan the internal diameter ofpipes.The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by the Engineer.

It shall also be ascertained by contractor that each stretch from manhole to manhole or the stretch as directed by Engineer is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line suitably enlightened by projected sunlight or otherwise.

Testingatwork site

After laying and jointing of RCC pipes is completed the pipe line shall be tested at work site as perthe following Employer’s Requirements and as directed by the Engineer. All equipment for testing at work site shall be supplied and erected by contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be contractor's responsibility and shall be rectified by him to full satisfaction of the Engineer. Water used for the test shall be removed from pipes and not released to the excavated trenches.

After the joints have thoroughly set and have been checked by the Engineer and before back fillingthe trenches, the entire section of the sewer or storm water drain shall be proved by the contractor to be water tight by filling in pipes with water to the level of 1.50m above the top of the highest pipe in the stretch and heading the water up for a period of one hour. The apparatus used for the purpose of testing shall be approved by the Engineer. Contractor if required by the Engineer shall dewater the excavated pit and keep it dry during the period of testing. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For the approval of this test the average quantity added should not exceed 1 liter/ hour/100 linear metres / 10mm of nominal internal diameter. Any leakage

including excessive sweating which causes a drop in the test water level willbe visible and the defective part of the work should be removed and made good.

In case of pressure pipeline, the completed stretch of pipeline shall betestedforsite test pressure.The site test pressure should not be less than the maximum operating pressure plus the calculated surge pressure, but in no case should it exceed the hydrostatic test pressure as specified in IS: 458.

All of results of test and inspection data must be prepared by contractor at site so that the Engineer shall make decision of “fail or pass” at once. All cost for the inspection shall be borne by the Contractor.

HydraulicLosses

Thefrictional lossesduetofluidflowin pipeworkshall becomputed,basedontheHazen-William formula using C=120

a) Valves

Thelossesinmwcshallbecalculatedasperempiricalformulask=coefficientshallbetakenas under.

k - for sluice valves

=0.2 fornon-returnvalves =

1.5

for penstocks

=asfurnishedbythemanufacturerwithdocumentary evidence.

b) Fittings,specials

For specials like reducers, bell-mouths, tees, elbows, etc, the `k' values shall be as recommended by the British Hydromechanics Research Association (BHRA), Volume 5, in the BHRA fluid Engineering Series.

FlexibilityinPipework

TheContractorshallprovideflexibilityinthepipeworkatjointsinthemainstructuresa ndshall submitproposalsfor the approval of theEngineer. Flexiblejointsorcollars and cutpipesshall be allowedon all pipe work where necessary toallowfor somemargin of error in the building work. Wherever possible flexiblejoints shall be provided(as per Engineer’s directive) with tie bolts or other means to transfer longitudinal thrusts as a whole so that external anchorages may be kept to a minimum.Flexible joints (SS Bellows and Dismantling joints) shall also be provided for case of erection and future dismantling of all valves and Equipment.Particular care shall be taken to ensure that pipe work thrusts are not transmitted to machinery or associated apparatus.

TheContractorshallindicateonhisdetaileddrawingswhatthrustblocksarerequired.

PuddleFlanges

Puddle flanges shall be fitted to pipes where the structure through which they pass is required to take thrust resulting form the pipe.Puddle flanges shall also be fitted where a water barrier is required.All puddle flanges shall be clearly shown on the drawing and the resultant thrust clearly indicated. Puddle flanges shall only be fitted with the Engineer prior approval.

SmallBorePipesand Hoses

Small bore pipes and hoses shall be of non-flame propagating materials.They shall be arranged for easy dismantlingforcleaning whereappropriate,andif screwed joint orjoints formed by solvent weldingare proposed for any chemical line, a sufficient numberof flanged or flexible joints shall be provided toenable the pipe work to be removed in sections withoutworking fromone end to the other of a particularrun. Tees and cocks shall also be provided at convenient points for the connection of a pressure water supply to flush pipe work through as required.

All pipes and hoses shall be labelled to enable individual lines to be identified throughout their run. Racks or trays shall be fixed tothe ductwallsor walls of tanks andbuildingsandthe chemical pipes shall be fixed to these racks ortrays withclipswhichcaneasilyberemovedwithout dismantling adjacent pipes.The Contract includes for the supply and fixing of all such racks or trays. Full details of the type of hoses, pipes and racks of trays proposed, shall be submitted at the time of tendering.

SupportofPipeworkandAccessories

All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipe workand its associatedequipment in anapproved manner.Valve, meters, strainers, and other devices mounted in the pipe work shall be supported independently of the pipes to which theyconnect.

All brackets or other forms of supports, which can conveniently be so designed, shall be rigidly built up of steel by riveting or welding in preference to the use of castings.

No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Engineer.

After the collars and boxes or other fitting have been fixed in position, the floors, walls and roof structure will be made good by the Contractor.

CastIron Pipes

Marking

Eachpipeandfittingshallhavecast,stampedorindeliblypaintedonitthefollowingappropriate marks:

i) Thenominal diameter.
ii) Flowdirectionandlinemarksfor installation
iii) Classreference
iv) Massof pipe
v) Dateofmanufactureand
vi) Manufacturer'sname,initialsoridentificationmark.

MarkingshallbedoneasperrelevantIS code.

Jointing

General

Jointing of CI pipes and fittings shall be done as per the requirements of following Employer’s Requirements and as per the relevant IS.After jointing, extraneous material, if any, shall be removed from the inside of the pipe. In case, rubber sealing rings are used for jointing, these shall conform to IS: 5382.

Tyton joints

In jointing cast iron spigot and socket pipes and fittings with tyton flexible joints the contractor shall take into account the manufacture's recommendations as to the methods and equipment to be used in assembling the joints. In particular the contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, that the rubber ring as per IS: 5382, is correctly positioned in line, before the joint is made. The rubber rings and any recommended lubricant shall be obtained only through the pipe supplier or as otherwise directed by Engineer.

FlangedPipes

The gaskets used betweenflanges of pipes shall be compressed fibre board or natural/synthetic rubber conforming to IS: 638, of thickness between 1.5 to 3 mm. The fibre board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per square metre shall be not less than 112 g/mm thickness.

Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternately. The practice offully tightening the bolts one after another is highly undesirable.The bolts shall be of mild steel unless otherwise specified.

Cleaningof Pipesand Fittings

The Contractor shall ascertain that each stretch of pipeline is absolutely clear and without any obstruction by means of visual examination of the interior of pipeline suitably lighted by projected sunlight or otherwise. The open end of an incomplete stretch of pipeline shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipeline, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by the Engineer.

Testingatwork site

After the pipes and fittings are laid, jointed and the trench partially backfilled except at the joints the stretch of pipe line as directed by Engineer shall be subjected to pressure test and leakage test. Where any section of the pipeline is provided with concrete thrust blocks or anchorages, the pressure testshall not be made until at least five days have elapsed after the concrete was cast. If rapid hardening cement has been used in these blocks or anchorages, the tests shall not be made until atleast two days have elapsed.

Each section of the pipe line shall be slowly filled with water and all air shall be expelled from the pipe by tapping at points of highest elevation before the test is made and plugs inserted after the tests have been completed.The specified test pressure based on the elevation of the lowest point ofthe line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe as directed by the Engineer.

The duration of test shall not be less than 5 minutes. The exposed joints shall be carefully examined and all suchjoints showingvisibleleaks shall berecaulked until water tight. Any cracked or defective pipes and fittings in consequence of this pressure test shall be removed and replaced by soundmaterial byContractor at no extra cost tothe Engineer and the test shall be repeated tothesatisfaction of the Engineer.

After the satisfactorycompletion of pressure test,the section of pipeline shall

besubjected to leakage test. The duration of test shall be 2 hours. No pipe installation shall be accepted until the leakage is less than the number of cm3/h as determined by the formula:

$$q_L = \frac{ND\sqrt{P}}{3.3}$$

Where,

q_L = Theallowableleakageincm^3/hr

N = Numberofjointsinthelengthofthepipeline

D = Diameterinmm,and

P = Theaveragetestpressureduringtheleakagetesti nKg/cm^2

Should any test of pipe laid indicate leakage greater than that specified above, the defective jointsshallberepairedbyContractoratnoextracostto theEngineeruntiltheleakageiswithinthespecified allowance.

Necessary equipment and water used for testing shall be arranged by Contractor at his own cost. Damage during testing shall be Contractor's responsibility and shall be rectified by him atno extra cost to the Engineer. Water used for testing shall be removed from the pipe and not released in the excavated trenches.

After the tests mentioned above are completed to the satisfaction of the Engineer, the backfilling of trenches shall be done as per the Employer’s Requirements specified elsewhere.

UnplasticisedPVC PipesandFittings

Unplasticised polyvinyl chloride pipes,fittings and specials shall be to BS 3505for potable water and BS 4346: Part 1 for fittings.

The pipes shall be of the spigot and socket type with approved gasket type flexible joint. The rubber gaskets shall be to BS 2494, Class C.

Where PVC pipes, fittings and specials are to be connected to cast iron, stainless steel or steel pipes, all metallic pipes, ‘Viking Johnson’ type flange adaptors or stepped couplings shall be used.

Polyethylene Pipes

Polyethylene pipes shall comply with BS 6437. The welding method shall be adapted to international standard and contractor shall obtain the approval of the Engineer before proceeding with such works.

RubberHosing

Rubber hosing shall conformto BS 5119, Type 2. It shall be capable of handlingchlorine and sulphur dioxide solutions at a working pressure of 12 bar.

CopperTubes and Fittings

Copper tubing and fittings for work above ground level shall comply with BS 2871 and BS 864: Part2 respectively and be jointed with capillary joints. For underground location the copper pipe shall beto BS 2871: Part 1.

FlangedJoints

All flanges shall comply with BS EN 1092-1/BS 4504. The nominal pressure rating for particular flanges shall be at least equal to the highest pressure rating of the pipes or fittings to which they are attached, but with a minimum nominal pressure of PN 10. All flanges shall be provided with all necessary nuts, bolts, washers and gaskets. In general, valves shall have flanged body ends.

All flanged joints which are buried or in chambers shall be protected with Densomastic andDensotape wrapping, applied in accordance with the

manufacturer's instructions.

Flangesshallbeinstalledonthepipesinthefactoryandfieldweldingofflangesshallonly beallowed with the approval of the Engineer.

Where pipework outside pumping stations and surge vessel chambers is cathodically protected, an insulated flange shall be incorporated at the first flange inside the structure. These flanges shall be tested to ensure that electrical insulation is achieved.

Gasketsand Joint Rings

Joint rings shall be manufactured to conform with BS 2494 and shall be of chloroprene rubberorother approved synthetic material suitable for temperatures up to 80ºC.

Gaskets may be inside the bolt circle type and shall comply with BS 4865: Part 1. Alternatively the gasket shall be to the full diameter of the flange, drilled to suit the appropriate bolt provisions.

Chloroprenerubberwithahardnessof71to80IRHDshallbeused.

Jointsshallbemadeinaccordancewithmanufacturer'sinstructionsorasspecifiedherein.

Until immediately required for incorporation in a joint, each rubber ring or gasket shall be stored inthe dark, free from the deleterious effects of heat or cold, and kept flat so as to prevent any part of the rubber being in tension.

Only lubricants recommended by the manufacturer shall be used in connection with rubber rings and these lubricants shall not contain any soluble constituent, shall be suitable for the climatic conditions at the Site and shall contain an approved bactericide.

Aftercleaningtheflangesthegasketsshall

befittedsmoothlytotheflangeandthejointshallbemade by tightening the nuts to finger pressure first. Thereafter the final tightening of the nuts shall be made

bygraduallyandevenlytighteningboltsindiametricallyoppositepositionsusingstandardspanners Graphite grease shall be applied to the threads of bolts before joints are made.

FlexibleCouplingsandFlange Adaptors

FlexiblecouplingsandflangeadaptorsshallbeoftheVikingJohnsonorsimilarapprovedpatternand be assembled in accordance with the manufacturer's instructions and protected, if buried or in chambers with Densomastic and Densotape wrapping applied in accordance with the manufacturers' instructions. Flexible joints shall be harnessed or tied where necessary.

Storage& Shipment

ProtectionofPipesandFittingsforShipment

Except where otherwise specified all items shall have received their complete protective coatings before dispatch fromthe manufacturer's works and shall be additionally protected by approved means for the period of transit, storage and erection, against corrosion and accidental damage.

For the protection of pipe linings and in particular for protecting cement mortar linings from drying out, protective metal or timber discs shall be fitted over the ends of pipes and fittings. Similar timber protective discs shall be attached to all flanges of pipes and fittings, by means of bolts specifically provided for the purpose and which shall be discarded when the item is incorporated in the Works. The sleeves and flanges of flexible joints shall be wired together in suitable bundles.

StorageofPipeline Materials

Pipes and fittings shall be stored raised off the ground, and shall be carefully supported, cushionedand wedged. Pipes shall not rest directly on one another and shall not be stacked more than four pipes high or two pipes high in the case of pipes of 500 mm diameter or over. Special care shall be taken to ensure that flexible pipes are cradled and supported in a manner that prevents any distortion of the pipes.

Couplings and joints (and all components thereof) and other similar items shall be stored in dry conditions, raised from the ground in sheds or covered areas.

Storageareasshall
becarefullysetouttofacilitateunloading,andcheckingofmaterialswithdifferent consignments stacked or stored separately with identification marks clearly visible.

Where items to be stored have a limited shelf life or require special storage arrangements, the method of storage shall be to the approval of the Engineer and in accordance with the manufacturer's instructions.

All pipes and fittings supplied as spares shall have end covers which are proof against the entry of sand and vermin. Mortar lined pipes and fittings shall have end covers which form a complete seal, provision being made to accommodate the effects of temperature changes. Pipes and fittings supplied as spares shall have a temporary white external finish and shall be stored sheltered from the directrays of the sun.

End covers and protection shall not be removed until incorporation of the pipes and fittings into the Works.

TransportationofPipesandFittings

Any vehicle on which pipes are transported shall have a body of such length that the pipes do not overhang. Large pipes shall be placed on cradles and the loads properly secured during transit. The pipes shall be handled in accordance with the manufacturer's recommendations.

Approved slings shall be used and all hooks and dogs and other metal devices shall be well padded. Hooks engaged on the inner wall surface at pipe ends shall not be used. Steadying ropes shall be employed. The positions of lifting slings shall ensure that stresses and tendency towards deformation in the pipes are kept at a minimum.

Pipe handling equipment shall be maintained in good repair and any equipment which in the opinion of the Engineer may cause damage to the pipes shall be discarded.

Under no circumstances shall pipes be dropped, be allowed to strike one other, be rolled freely or dragged along the ground.

Inspectionof PipesandFittings

Before incorporating into the Works each pipe shall be brushed out and carefully examined for soundness. Damaged pipeswhichintheopinionoftheEngineercannot be satisfactorilyrepairedshall be rejected and removed from Site.

Damagetopipecoatingsorliningsshallberepairedtothesatisfactionofthe Engineer.

Built-inPipeworkandotherPlant

ThepipesandotherPlantinwaterretainingstructuresshall,whereverpossible,bebuil tinasthework on the structure proceeds. The Contractor shall ensure that delivery of the requisite pipe work and other Plant is in accordance with the requirements of the programme.

Where a pipe subject to thrust passes through a concrete structure or where an external seal isrequired, a puddle flange shall be used. The puddle flange dimensions shall be to BS EN 1092-1/BS 4504 but shall be undrilled. The exterior of the pipe shall be cement washed symmetrically about the puddle flange by the manufacturer for a length at least equivalent to the thickness of the wall through which it passes.

The Contractor shall be responsible through every stage of the Works for checking the correctness of the setting of built-in Plant and shall satisfy himself they are positioned in accordance with his approved drawings.

Pipelaying

Carting& Handling

Pipes and fittings /specials shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by the Engineer. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading.Every care shall be exercised in handling pipes and fittings/specials to avoid damage. While unloading, the pipes and

fittings/specials shall not bethrowndownfromthetruckontohardsurfaces.Theyshouldbeunloadedontimberskidswith

steadying ropes or by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervalsin order to permit access fromone side to other. In case ofspigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded. Dragging of pipes and fittings/specials along concrete and similar pavement with hard surfaces shall be prohibited.

Storage

Eachstackofpipesshall containonlypipesofsameclassandsize,withconsignment orbatchnumber marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stackshall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stock shall not exceed 1.5 m.

Fittings/Specialsshallbestackedundercoverandseparatedfrompipes.

Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipmentandpetrol,oilsorotherchemicals.Particularlyinthefieldwherethe rubberrings are being used it is desirable that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.

Laying

Excavation

Before excavating the trench the alignment of pipeline shall be approved by the Engineer. The excavation of trenches and pits for manholes/ chambers shall be carried out in accordance with the Employer’sRequirementsdescribedelsewhereandshallbedonesuchthatitdoesnotg

etfaraheadof the laying operation as approved by the Engineer.

To protect persons from injury and to avoid damage to property, adequate barricades, constructionsigns,redlanternsandguardsasrequiredshallbeplacedandmaintainedduring the progress of the construction work and until it is safe for the traffic to use the roadways. TherelevantIndianStandardsandtherulesandregulationsoflocalauthoritiesinregardsto safety provisions shall be observed.

Suitablefencingshallbeprovidedalongthesidesoftrenchesandpits.Thepostsoffencingshallbeof timber securely fixed in the ground not more than 3 m apart and they shall not be less than 75 mm in diameter or less than 1.2m above surface of the ground. There shall be two rails, onenear thetop of the post and the other about 450mm above the ground and each shall be from 50mm to 70mm in diameter and sufficiently long to run from post to post to which they shall be bound with strong rope. The method of projecting rails beyond the post and tying them together where they meet will not be allowed on any account. All along the edges of the excavation trenches a bank of earth about 1.2 m high shall be formed where required by the Engineer for further protection.

The road metal and also the rubble packing shall first be stripped off for the whole width of the trench/pit and separately deposited in such place or places as may be determined by the Engineer.

During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leavingadequatecleardistancefromtheedgesofthetrenchandpit,orasmaybe necessarytoprevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoidcoveringfire hydrants, sluice valves, manholes and covers etc. and so asto avoidabuttingthe wall or structure or causing inconvenience to the public and otherservice organizationsor otherwise as the Engineer may direct.

Contractor shall take into account additional excavation if any as the Engineer may require in order locating the position of water pipes, drains, sewers etc. or any other works which may be met with, in or about the excavation of trenches/pits while quoting the rates for excavation of trenches /pits while quoting the rates of excavation. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting,

planking over, padding or otherwise as the Engineer may direct, and shall be protected by the Contractor from damage during the progress of the work. All precautions shallbe taken duringexcavationand layingoperationsto guardagainst possible damage to any existing structure /pipe line of water, gas, sewage etc.

Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than the minimum requirement. In case additional width is required it shall be provided only in the top portion from the ground level upto 300 mm above the top of pipe. If any extra width is provided in the area belowthis portion, Contractorshallhaveto provideremedial measuresintheformof lime concreteor rubble masonry otherwise at the discretion and to the satisfaction of the Engineer. If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings/specials and the space resulting shall berefilled with granular materials and properly consolidated. Bottom of trenches/pits shall be saturated with water well rammed wherever the Engineer may consider it necessary to do so.

Wherever a socket or collar of pipe or fitting/ special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe mayhaveafairbearingonitsshaftanddoesnot rest uponitssocket.Suchgripshall beofsufficientsizein every respect to admit the hand all around the socket in order to make the joint and the grip shall be maintained clear until the joint has been approved by the Engineer.

When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60cmin depth and 90cmin length shallbe made atjointsin order to facilitate welding.

The excess excavated material shall be carried away from site of works to a place up to a distance as directed by the Engineer. This shall be done immediately so as not to cause any inconvenience to the public or traffic. If the instructions from Engineer are not implemented within seven days from the date of instructions to cart the materials and to clear the site, the same shall be carried out by the Engineer and any claim or dispute shall not be entertained in this respect.

Dewatering

During the excavation, if subsoil water is met with Contractor shall provide necessary equipment and labourers for dewatering the trenches.The Contractor shall also make necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by the Engineer. In no case the water shall be allowed to spread over the

adjoining area. Before discharging this water into public sewer/drain, the Contractor shall take necessary permission from the local authorities.

SpecialFoundationinPoorSoil

Where the bottom of the trench and sub grade is found to consist of material whichis unstableto such a degree that inthe opinion of the Engineer, it cannot be removed and replaced with anapproved material thoroughly compacted in place to support the pipeproperly, a suitable foundation for the pipes, consisting of piling, timbers or other materials, in accordance with relevant drawings to be prepared by the Contractor and as instructed by the Engineer shall be constructed.

WoodenShoring

Contractor shall suitablydesign pollingboards, walingand struts to meet different soil conditions that mightbeencounteredinexcavatingtrenches/pits.Thehorizontalandverticalspacing ofstrutsshallbe such that not only the sides of trenches shall be prevented from collapse but also easy lowering ofpipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and/or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by Contractor shall be his sole responsibility.No part of shoring shall at any time be removed by Contractor without obtaining permission from the Engineer. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earthwell rammed with rammers and with water.

The Engineer may order portions of shoring to be left in the trenches /pits at such places, where it is found absolutely necessary to do so to avoid any damage which may be caused to buildings, cables, gas mains, water mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations. The Contractor shall not claim, on any reason whatsoever, for the shoringwhich may have been left in by him at his own discretion.

SteelPlateShoring

Where the subsoil conditions are expected to be of a soft and unstable character in trench/pit excavation, the normal method of timbering may prove insufficient to avoid subsidence of the adjoining road surfaces and other services. In such circumstances, the Contractor will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, waling etc., as per the

instructions, manner and method directed by the Engineer. Contractor shall supply pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the Employer’s Requirements.

BoningStavesandSight Rails

In laying the pipes and fittings/ specials the centre for each manhole / chamber or pipeline shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 x 100 x 1800 mm) at each manhole/chamber or junction of pipelines at nearly equal distance from the peg and at sufficient distances there from to be well clear of all intended excavation, so arranged that a sight rail whenfixed at a certain level against the post shall cross the centre line of the manhole/chamber or pipelines. The sight rail shall not in any case be more than 30 m apart; intermediate rails shall be put up if directed by the Engineer.

Boning staves of 75 mm x 50mm size shall be prepared by Contractor in various lengths,eachlength being ofa certain whole number of metersand with a fixedtee head and fixed intermediate cross pieces, each about 300 mm long. The top-edge of the cross piece must be fixed below the top- edge of the tee-head at a distance equal to the outsidediameter of the pipeor the thickness of the concrete bedto be laid asthecasemaybe.Thetop of cross piecesshall indicatedifferent levelssuch as excavation for pipe line, top of concrete bed, top of the pipe etc. as the case may be.

The sight rail of size 250 mm x 40 mm shall be screwed with the top edge resting against the level marks. The center line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the center lines of any converging pipes. A line drawn from the top edge of one railto the top edge of the next rail shall be verticallyparallel withthe bed of the pipe,and the depth ofthe bed of pipe at any intermediate point may be determined by letting down the selected boning staffuntil the tee head comes in the line of sight from rail to rail.

The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, andthetee-heads andcross-piece ofthe boningstaves shall bepainted black.

For the pipes converging to a manhole/chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 M of the surface of the ground, a higher sight-rail shall be fixed for use with the rail over

the next point.

Theposts and rails shall inno case beremoved until the trenchis excavated, the pipesarelaid and the Engineer gives permission to proceed with the backfilling.

Layingof PipesandFittings/Specials

All precautions shall be taken during excavation and laying operations to guard against possible damage toanyexistingstructure/pipelineofwater,gas,sewageetc.Afterexcavationoftrenches,pipesshallnotbe lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Employer /Engineer. Pipes and fittings/specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings/specials shall be made by Contractor. In no case pipes and fittings/specials shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the endsof pipes and fittings/specials shall be used to lift and lower the coated pipes and fittings/specials. The pipes and fittings /specials shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, further confirmation shall be done by pouring a little kerosene/dye on the inside of the pipe at the suspected spot. No sign of kerosene/dye should appear on the outside surface. Pipes and fittings/specials damaged during lowering or aligning shall be rejected by the Engineer.

All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which casethesocket endsshould facethe upgrade.The layingof pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and thepipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings/specialswhich do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings/specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times whenpipe laying is not in progress, the open ends of pipe shallbe closed by a watertight plug or other means approved by the Engineer. During the period that the plug is on, the Contractor shall take proper precautions against floating of the pipe owing to entry of waterintothetrench.Wherever it isnecessarytodeflect pipefromastraight line,either inthevertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2 ½0. In case of pipes, with joint to be made with loose collars, the collars shall beslipped onbeforethenext pipeislaid.Thepipesshall belaidsuch that the markingon pipes appears at the top of the pipes.

The cutting of pipe for inserting valves, fittings, or specials shall be done in a

neat and workman like manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used.

ThrustBlocks

Thrust Blocks shall be provided for all piping works, to counteract hydraulic thrust, at placeswherever directed by the Engineer as per approved design.

Jointing

Jointing for pipes and fittings/specials shall be done in accordance with the relevant Employer’s Requirements depending upon the type of pipes being used.

Testingand Commissioning

Testing and commissioning of pipes shall be done in accordance with the relevant Employer’s Requirements.

Backfilling

Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipeline. The tamping around the pipe shall be done by hand or other hand-operated mechanical means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur. Backfillingshall bedonein layers not exceeding30 cm. Each layer shall be consolidated by watering, ramming, care bring taken to avoid damage to the pipeline. In case of the mild steel pipes/specials, the spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipeline to aid alignment, these timbers shall be removed before backfilling.

The Contractor is requested to provide the method of Backfilling compaction test and evaluationvalue and obtain the approval from the Engineer.

Reinstatementof Road/Footpath

Reinstatement of road/footpath shall be done as per the requirements of local authorities and the Employer’s Requirements after completion of work.

ClearingofSite

All surplus materials,and alltools and temporarystructures shall beremoved fromthe site as directed by the Engineer and the construction site left clean to the satisfaction of the Engineer.

DisinfectionofWaterMains

The mains intended for potable water supplies should be disinfected before commissioning them for use.Special care should be take to ensure disinfection of new mains. Among possible sources of contamination are sewer drainage, contaminated soil in the trench, contamination from workmen or their equipment of both and unavoidable foreign material present in the trench during construction.

Educationofcrewmembersastotheneedforavoidingcontaminationofthemaindurin gconstruction is fundamental. Contractors and workmen should be thoroughly familiar with all pertinent state and local requirements governing installation of mains. All sewers, water mains and other underground conduits should be located prior to construction relocated, if necessary, to prevent contamination during construction. Pipe should be strung on high ground. At all times when construction is not actuallyinprogress,watertightplugsshouldbeinstalledinallpipeopenings.Gunnysac kandragsare not adequate. Provision should be made to pump any other water that might collect in the trench. Special care should be taken to avoid contamination of valves, fittings, and pipe interiors, both before and during construction each of them should be inspected and, if necessary, cleaned beforeinstallation.

After pressure testing the main, it should be flushed with clean water at sufficient velocity to remove alldirtandotherforeignmaterialsintheconstructedpipeline.Whenthisprocesshasbe encompleted, disinfection (using liquid chlorine, sodium or calcium

hypochlorite) should proceed by one of the recommended methods as described in the following

ContinuousFeed

In this method, water from the distribution system or other approved source and the chlorine is fed at constant rate into the new main at a concentration of atleast 20 mg/1. A property adjustedhypochlorite solution injected into the main with a hypo chlorinator, or liquid chlorine injected intothe main through a solution feed chlorinator and booster pump may be used. The chlorine residual should be checked at intervals to ensure that the proper level is maintained. Chlorine application should continue until the entire main is filled. All valves, hydrants, etc., along the main should be operated to ensure their proper disinfection. The water should remain in the main for a minimum of24 hours. Following the 24 hours period no less than 10 mg/1 chlorine residual should remain in the main.

The Contractor is requested to provide photo and take a record the value of chlorine residual atstarting point and after 24 hours before completion of work.

The Engineer shall jointly check the test at sites. If the value is insufficient, the disinfections work shall be repeated until satisfactory results are achieved.

Wastechlorineresidualwatermustbeneutralizedbeforeitisdischargedtoanydrainage.

SlugMethod

In this method a continuous flow of water is fed with a constant dose of chlorine (as in the previous method) but with rates proportioned to give a chlorine concentration of at least 300 mg/1. Thechlorine is applied continuously for a period of time to provide a column of chlorinated water that contacts all interior surfaces of the main for a period of at least 3 hours. As the slug passes tees, crosses, etc., proper valves shall be operated to ensure their disinfection. This method is used principally for large diameter mains where continuous feed is impractical.

Regardless of the method used, it is necessary to make certain that backflow of the strong chlorine solution into the supplying line does not occur. Following

the prescribed contact period, the chlorinatedwatershouldbeflushedtowasteuntiltheremainingwaterhasachlorinere sidual

approximating that throughout the rest of the system. Bacteriological tests as prescribed by the authorities should be taken, and if the results fail to meet minimum standards, the disinfecting procedure should be repeated and the results again tested before placing the main in service.

If continuous feed method is difficult to apply, Retention Method shall be considered as alternative way.

The area or pipe line to be disinfected shall be fed with chlorine solution from up stream under flowing water condition, and then the area shall be blocked after make sure to reaching more than 20 mg/l. The chlorine solution fed in the pipeline needs to wait for 1 day before starting measurement of residual chlorine.After3dayslater,thechlorineresidual valueshall betestedatsamplingpointsat up stream and at downstream near to end to check whether the value is in range or not.

The Contractor shall provide photo and take a record the value of chlorine residual at starting point and after 24 hours before completion of work.

The Engineer shall jointly check the test at sites. If the value is insufficient, the disinfections work shall be repeated until satisfactory results are achieved.

Waste chlorineresidual water must be neutralized before it is discharged to anydrainage, as approved by Engineer.

EndofPart11

PART12

PARTICULARELECTRICALPLANT REQUIREMENTS

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PART12

PARTICULARELECTRICALPLANTREQUIREMENTS

Introduction

Thespecificdesignandperformancerequirementsforallelectricalequipmentaregiveninthispartof the Specifications. The Requirement specified shall be fully met with by the Contractor. In case of any deviations, the Contractor shall bring out the same in “Schedule of Deviations from Particular Requirement” failing which shall be considered that the Contractor fully complies with these requirements. General Requirement of electrical equipment is covered under Part-6 of this specification. Tender drawings provided with this tender are for **reference purpose only**.

Scopeofworks

ThescopeofworksforISPSincludesdesign;manufacture;testingatworks;supplyand deliveryat site; unloading and storing the equipment at site of installation; installation, testing and commissioning of the following equipment at site.

11kV Outdoor VCB Panel, 11/0.433kV transformers, 415V Diesel Generator Sets with Acoustic Enclosure & AMF Panel, 415V Metal enclosed switchboards / distribution boards / Motor Control Centres / Local control Panels / Junction Boxes, 415V capacitor banks with detuned filters and APFCR panel, 110V DC Battery, Battery charger, DC Distribution board, LV Variable Frequency drives,415VNonsegregatedbusducts,LEDLightingsystem,Power&controlcables, Cablecarrier & support system, Earthing & Lightning protection system.

All equipment / items shall be of makes as specified in the list of preferred makes.
Variousequipment/itemsshallconformtolatestapplicablestandardsspecifiedandlat

estamendments.Incase of Conflict between standards and this specification, this specification shall govern.

PowerSupplyArrangement

AttheproposedISPSplantlocationthereisnoexistingincomerpowerarrangementandhence incoming power supply shall be taken new from the nearest BESCOM substation.

BESCOMshallmakingnecessarymodificationsintheirsubstationbyaddingextra11kVswitchgear/ Breaker, laying 11kV overhead line / underground cable up to the RMU/Spun Pole in new ISPS location. Necessary RMU/Spun Pole, CTs, PTs, interconnecting cable from RMU/Spun Pole to metering unit, metering unit shall be provided by BESCOM.

TheIncoming11kV(overheadline/ undergroundcable)supplyfromBESCOMshallbeterminatedat RMU/Spun Pole. Outgoing terminals of the RMU/Spun Pole shall be connected further to outdoor/indoor 11kV BESCOM metering unit.

Theoutgoingcablefromthemeteringunitshallbeconnectedto1No.Outdoor11kVVCBpanelwith 1 No. incoming from BESCOM metering and 2 Nos. of outgoing to 2 Nos. of transformers.

Themaximumtransformerratingshallberestrictedto2500kVA.

The415VsideofthetransformersshallfeedtoPCCpanelforfurtherpowertotheISPSloads through starter panels.

The above-mentioned works upto the BESCOM metering unit will be executed by BWSSB/BESCOM.TheaboveworksmaybecarriedoutbyBWSSBasDepositContributionWorks or Self Execution Basis which may be decided after the award of contract.

WorksforISPSstartingfromoutgoingside(cableterminationpoint)of11kVmetering ,providingan outdoorVCBpanel after BESCOMmetering&all worksasmentionedabovewill beincludedunder ISPS contractor scope.

Liaisoning with BESCOM for getting construction power supply, making new power supply agreementfortheplant,andgettingfinalclearancefromCEIGforcompleteElectricalsystemwillbe included under ISPS contractor scope.

Thebelowequipmentshallbeinstalledoutdoorwithfencing&gates

a) 11kV Metering,
b) 11kVVCB panel,
c) Transformers

DGshallbeinstalledoutdoorwitha Shed.

Contractorshalldesigntheelectricalsystemwhichshallhavenecessaryprovisionfor monitoringthe specificenergyconsumptionandshall beconnectedtoplant SCADAforremotemonitoring/display.

- ISPSunits

SeparateMCCpanelroomsshall beconsideredforplacingMCCpanels,lightingpanels&PLC panels (if any) for ISPS pumping station as a minimum.

GeneralDesignCriteriaforISPS

Allelectricalequipmentshallberatedfor45 ^{0}Cdesignambienttemperature.Theinstallationshall conform to Indian Standards / IEC.

Thefollowingfactorsshallbeconsideredforproperselectionofelectricalapparatusor equipmentfor areas where flammable gas or vapours may rise.

Area classification

Theclassificationofareashallbeasper IS16724:2018&IS5572, basedonthedegreeofprobability with which explosive concentrations of combustible gas or vapour may arise in installations in terms of both the frequency of occurrence and probable duration of existence on each occasion.

(i) Zone0–Inwhichanexplosivegas/ airmixtureiscontinuouslypresentorpresentfor long periods.

(ii) Zone1–Inwhichanexplosivegas/airmixtureislikelytooccurinnormaloperation.

(iii) Zone 2 – In which an explosive gas/air mixture is not likely to occur in normal operation and if it occurs, it shall exist only for short periods.

GasGroupClassification

The characteristics of the gas or vapour involved in relation to igniting current or minimum ignition energyincaseofinstallationsofintrinsicallysafeapparatusormaximumexperimenta lsafegapdata in case of installations for flame proof enclosures as per IEC 60079-1.

TemperatureClassification

TheIgnitiontemperatureofthegasorvapourinvolved,orthelowestvalueofignitionte mperatureif more than one combustible material shall be present.

The maximum temperature of any unprotected surface of electrical equipment shall not exceed the ignition temperature of gas or vapour. For electrical apparatus, no margin of safety need be applied between maximum surface temperature and ignition temperature. The ignition temperature of combustiblegasesandvapoursaremeasuredinaccordancewiththetestmethodpres cribedinIS/IEC 60079-20-1.

Environmentalconditions

Environmentalconditionsinwhichtheapparatusshallbeinstalled.Apparatusanditsc omponentparts shall be constructed to guard against electrical and mechanical failures in the intended conditions of use.

Theselectionoftypeofprotectionofelectricalequipmentforthedifferentzonesof Hazardousareas shall be made in accordance with IS 16724 / IEC 60069-14.

Allelectricalequipmentinstalledinhazardousareasshallconfirmtoselectionofequip mentand installation guidelines of IS 16724 / IEC 60069-14.

MV System

a) Nominalvoltage	:	11kV
b) Numberof phases	:	3
c) Frequency	:	50 Hz
d)Connection	:	3 Wire
e)MaximumFaultLevel/current	:	500A(26.25kA)

LV System

GeneralSupply

(i) Voltage:	:	415Vnominal
(ii) Frequency:	:	50Hz
(iii) Connection	:	4wire
(iv) Noloadtransformervoltage	:	433V
(v) Systemearthing	:	Solidlyearthed
(vi) Maximumfaultlevel/current	:	36MVA(50kA)

AllPlantshall,unlessotherwisespecified,becapableofcontinuousoperationatavoltagelevelinthe range of 90% to 110% of the relevant nominal voltage and a frequency variation of plus 5% minus 5% with a maximum combined tolerance of 10%.

ACControl,LightingandSpaceHeating

- Voltage:	240V
- Phases:	1
- Frequency	50Hz
- Connection	2wire(Phase&Neutral)

DCControl,ProtectionandAlarm

- Voltage:	110V
- Phases:	1
- Connection	2wire(unearthed)

SystemProtection

Numericalrelay-basedprotectionsystemforvariouspartsofthepowersupplysystemshallbe proposed. The following protection systems shall be used:

(a) 11kVIncomer Feeder

- Instantaneousphaseovercurrent protection
- Instantaneousearthfaultprotection

- Inversedefiniteminimumtimephaseovercurrent protection
- Inversedefiniteminimumtimeearthfaultprotection
- Potentialtransformerfusefailureprotection
- Undervoltageprotection
- Negativephasesequenceprotection
- Breakerfailureprotection
- Inrushprotection

(b) 11kVTransformerFeeder

- Inversedefiniteminimumtimephaseovercurrent protection
- Inversedefiniteminimumtimeearthfaultprotection
- Instantaneousphaseovercurrent protection
- Instantaneousearthfaultprotection
- StandbyearthfaultProtection
- Thermaloverloadprotection
- Inrushprotection
- Breakerfailureprotection
- Windingtemperaturehigh,alarm&trip
- Oiltemperaturehigh,alarm&trip
- Buchholzrelayalarmandtrip
- Magneticoillevelgaugealarm
- RestrictedEarthFaultrelaytobeprovidedforTransformerrating2MVAandabove
- Pressurereliefvalvealarm& trip
- Oilsurgerelay trip
- Alarmannunciationwithconnectivity(communicationportRS485)toPLC

(c) 415VIncomerFeeder

- Overload,Earthfaultandshortcircuitprotection
- UndervoltageProtection

(d) LVMotors

(i) Motorsupto11kW

- overloadprotectionbythreephasethermal(bimetal)relay
- Singlephasingpreventer
- MotorProtectionCircuitBreaker(MPCB)

(ii) Motors15kWupto 75kW

- Electronicmotorprotectionrelayprovidingthefollowingprotection
- Overload
- Earthfault
- phasecurrentsoutof balance
- Singlephasingpreventer
- MCCB

(iii) Motorsabove75kW

- Comprehensivemotorprotectionrelayprovidingthefollowingprotection
- ThermalOverload
- lockedrotor
- PhaseOvercurrent(50/51)
- Earthfault(50N/51N)
- Overvoltage&undervoltage
- phase loss/reversal
- Negativesequence
- Protectionforrepeatedandprolongedstarts
- restartinhibition
- Singlephasingpreventer
- TemperatureMonitoring(Alarm&Trip)
- ACB/MCCB

Note:-RTD’sofWindingandBearingTemperaturesofPumps/ Motorsshallbemonitoredthrough Temperature Scanner Indicators.

(iv) Pump Drives

Allpumpsshallbeprovidedwiththefollowingadditionalprotection,aspe r requirement:

- Dryrunprotection
- Temperatureprotection,(Submersiblepumps)
- Moistureentryprotection.(Submersiblepumps)
- Overpressure(positivedisplacementpumps)

(v) Blowers

Blowersshallbeprovidedwiththefollowingadditionalprotection:

- Overpressure

(vi) RotatingArmDrives

Rotatingarmdrivesshallbeprovidedwiththefollowingadditional protection:

- motiondetectors
- Overtorquedetectors

(vii) ValveActuatorDrives

Valveactuatordrivesshallbeprovidedwiththefollowingadditionalprotection:

- Overtorquedetectors

SwitchgearInstruments

(a) 11kVFeeders(Incomer,Transformer&outgoingfeeders)

- AnalogAmmeterforall3 phases
- AnalogVoltmeterwithselectorswitch
- kWmeter
- kWhmeter
- kVARhmeter
- Frequencymeter
- Powerfactor meter.
- DigitalMultifunctionmeterwithRS485connectivity

(b) 415VIncomerFeeders

- Ammeterwithselectorswitch
- Voltmeterwithselectorswitch
- kWmeter
- DigitalMultifunctionmeterwithRS485connectivity

(c) 415VMotorStarterFeeders

- Ammeterwithselector switch
- Voltmeterwithselectorswitch
- kW meters for Motorfeeders morethan 75kW
- MultifunctionmeterswithfacilitytoextracthistoricaldataforProc essAir Blower Feeders
- DOLStartersfor motorfeeders lessthanor equalto 5.5kW
- Star-DeltaStartersformotor feedersabove5.5kWandupto 30kW
- Line/NeutralSoftStartersformotorfeeders above 30kW

MVMetalEnclosed Switchboard

MVswitchboardshallbe11kVandshallbefloorstanding,sheetmetalenclosedwithIP4Xdegreeof protection, draw out type vacuum circuit breakers for incoming & outgoing feeders, control & protection. The switchboard shall be rated for a fault current not less than 26.25 kA (rms). All protective relays shall be numerical type.

DistributionTransformer-11/0.433kVTransformers

Thetransformersshallbeoutdoortype,ONAN,11/0.433kV,3 phase,50Hz,twowinding,Dyn11 withsolidlyearthedneutralwithOLTC.Theenergyefficiencylevel(EEL)ofthetransformershall comply with the latest amendment of IS 1180 with minimum EEL of Level II.

The transformers shall be sized considering15% contingencyof total workingload while arrivingat the final capacity of transformers. Two numbers of transformers shall be provided in each load locationsuchthatundernormal condition,eachtransformer shall beloadedupto50%andincaseof failureofanyonetransformer,thehealthytransformershallhavecapacitytotakeentireloadsoasto have 100% standby.

The transformers shall be designed such that at any point of time maximum loading (including ContingencyCapacity)onanysingletransformershallnotexceed85%offullloadcapacity.The maximum capacity of the distribution transformers shall be limited to 2500kVA.

StandbyDieselGeneratorSets

DieselGeneratorSetsshallbe415V,50HzStandbywithAcousticEnclosureandAMFpanelatISPS. StandbyGeneratorsets shall be sized for power backup forall the ISPS loads(quantityas mentioned in Particular Mechanical Requirements) which are required for continuous operation of the corresponding ISPS plant during main power failure. 10% contingency over these loads shall be considered while sizing the DG Set.

AllDGSetsshallbeincompliancetoCPCBIVemission norms.

AutomaticMainFailure Panel

AMF(AutomaticMainFailurePanel)panelshallbeprovidedfortheDieselGeneratorSet.Incaseof mains failure detected by an under-voltage relay mounted in the AMF panel, the main breakers (receivingthemainpowerfromBESCOM)shallbeswitchedoffunderautomode.Consequently,the standby generator starts in the auto mode. After the generator set reaching the rated speed and rated voltage, the generator circuit breakers shall be switched on to feed Diesel Generator power to the AMF panel. On restored main supply, the reverse sequence of the above shall be followed for the mains supply to feed power to the loads as in normal condition.

415VPCC/MCC

415VPCC/

MCC&415VDGPCCshallbeSinglefront,floorstanding,sheetsteelenclosedwithIP 54 Degree of Protection, Form–IV enclosure as per IS/IEC 61439 complete with Air circuit breakers/MCCB’s/MPCBs, Control &Protection.ThePCC / MCCshall beratedfor afault current not less than 50kA (rms) for 1 sec.

DoublefrontconstructionmaybeacceptableonlyincaseofspacerestrictionsintheEle ctricalRoom and for motor starter feeders and small feeders (below 630A).

Allfeedersofratings800AandaboveshallbeACBtype.Feedersbelow800Aandupto63Ashallbe MCCB. Ratings below 63A shall be MCB. Motor feeders upto 15kW shall be with MPCB.

In general, all switchgear/MCCs shall be provided with 20% fully equipped spares feeders/breakers.
AllMotorFeedersintheMCCPanelsshallhaveContactors,ON-OFF-TripindicationandOLRreset button.

415VBusDuct

Bus duct shall be considered for handling short distance high current requirement i.e., from transformer secondaryto415V PCC/ 415V MainLTpanel&DGPCCpanelto415V PCC/ 415V Main LT panel. Bus duct shall be considered for power requirements greater than 1000kVA.

Busductsshallbesizedforcontinuouscurrentcarryingandshortcircuitwithstand capacity

LocalControlPanel(LCP)

Foreachmotor:

- Local/Off/Remoteselectorswitchtobeprovided.3Pushbuttons“START/STOP/EMERGENCY STOP” shall be provided.
- Startpushbuttonoperatesonlywhentheswitchon LCPisin“Local” position.
- Stop push button shall operate only after pre-determined requirement of closing the delivery valve either in Local mode or Remote mode for 90kW and above pump motors.
- EmergencyStoppushbuttonoperatesirrespectiveofthepositionoftheselectorswitch.

When the selector switch on LCP is in “LOCAL” position, the motor shall be operated by push buttons on LCP and shall take into account only the specific fail-safe controls of the equipment (electrical protections,lowlevel forapump).WhentheselectorswitchonLCPisin“REMOTE” position the drive shall be operated from PLC

Motorizedvalvesshallbewithfullyintegratedcontrol Actuator.Theactuatorcomeswithintegrated:

- OneSelectorswitch“Remote/Local"
- Controlswitchfor:OPEN/CLOSE/STOP.
- LocalControlcubiclewithremoteoperationfromPLCwithpositionfeedback.

OperationLogicofSwitchgears

OperationLogicof415VMetalEnclosedSwitchboardatISPSSubstation:

- At normal condition, boththe Incomers shall bein Closed Positionandthe DG Incomer & Bus coupler shall be in Open Position.
- If any Incomer fails the faulty Incomer shall be in Open Position, the Bus coupler and the healthy Incomer shall be in Closed Position.
- In Case of Power Failure, DG Incomer & Bus coupler shall be in Closed Position and the Mains Incomer shall be in Open Position. The critical loads of the plant shall run on DG Set.

CapacitorBanksandPowerFactorCorrection

TheLTcapacitorbanksprovidedshallbeofbusconnectedtypewithAutomaticPowerfactor correction,thesystemshallbedesignedsuchthatapower factorofnot lessthan0.98shallbe maintained.

Automatically controlled multistage power factor correction shall be provided. 2 Nos. PFC panels providingnolessthan 8 number PFC stages per panelshall beprovided each connected toone bus section of the LT Switchboard. The PF on each bus section of the board shall be monitored and correspondingPFCcapacitorsswitchedinandoutautomaticallyindiscretestagestomaintainaset point PF value.

Each panel shall be configured such that no PFC capacitor stages shall operate when the standby generatorispoweringthesideofthedistributionboardtowhichshallbeconnected.Reactorsshallbe provided for the protection of capacitors.

MCCBs,Switches,Contactorsshallbesuitableformakingandbrakingcurrentofthecapacitors.The Panels shall be floor standing, sheet steel enclosed with relevant degree of Protection.

VariableFrequency Drives

FollowingminimumloadsshallbeprovidedwithVariablefrequencyDriveswithcommunication port. The below loads shall have separate individual VFDs for each type of load. Group loads operation from a single VFD panel is not allowed.

- ISPSPumps

110VDCPowerSupply

110VDCPowersupplyshallbeprovidedforprotectionandcontrolin11kVand415VSwitchgears for Substation Buildings.

AConventionalsystemoperatingat110VDCusingmaintenancefreerechargeableNi-Cdbatteries shall be provided and shall be complete with battery, battery charger with boost &trickle charging facilities, necessary controls, indications, and DC distribution board.

Cabling

(a) 11kVPowerCables

Thecablesshallbe3core,11kV(UE),XLPEtypewithstrandedaluminiumconductors& GI armouring. Minimumsize of cableshallbe selected based on the shortcircuitconsiderations.

(b) LVPowerCables

LVpowercablesshallbe1.1kVXLPEtypewithstrandedAluminiumConductorswithGI armouring for sizes above 6 sq.mm and stranded copper conductors with GI armouring for sizes 6 sq.mm and below. No. of cores shall be as per requirement.

(c) ControlCables

Controlcablesshallbe650/1100V,XLPEwithstrandedcopperconductorsandGIarmouring.No.of cores shall be as per requirement. Minimum size of core shall be 1.5 Sq.mm.

(d) CableRating

Allpowercablesshall besizedforcontinuouscurrentcarryingcapacityandpermissiblevoltagedrop at an ambient temperature of 45 degrees C. Due consideration shall be taken of cable grouping,

methodofinstallationandlocalvariationsinambientconditions.Further,forcablesco ntrolledby circuit breakers, due consideration shall be given to the fault level.

MVandLVcablesshallbesizedforaminimumfaultclearancetimeof

- 1secondforincomingfeeders
- 0.5secondfortiefeeders
- 0.25secondformotorfeeders
- 0.16secondfortransformerfeeder

ForallLTCables,thevoltagedropinthecablesbetweenthetransformerandtheswitch gear(PCC)or between PCCandMCCforfull load current shallbelimited to 2%. Furtherthe voltage drop in cables between PCC/MCCto Motor terminals for full load current shall belimited to 3%.TheTotalVoltage drop transformer secondary to motor terminal shall be limited to 5%.

Under motor starting conditions the corresponding voltage drop shall not affect the operation of the motorcontrolsortheabilityofthemotortostartandruneffectivelyandinanyeventshal lnotexceed 10%. The Contractor when sizing cables for the remote operation of shunt trip coils shall take due account of the voltage drop caused by the momentary current surge taken at the instant of energisation.

(e) CableInstallations

InsidetheBuilding/PumpHouse(ExceptbuildingslikeOffice/EmployersBldg./ GuardRoom/AdminBldg.)

Cables shall be routed either in RCC cable trenches or overhead cable tray with heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems (in chlorine, chemicalandothercorrosiveareas,FRPtypecabletrayshall beused).Theseshallbeusedtoroute cables along walls, below beams and within cable trenches. Cables shall be securely fixed to the support systems. Bundling of cables shall be permitted where allowance for this practice has been made while sizing the cables.

OutsidetheBuilding/PumpHouse

Allcableinstallationsoutsidetheplantareauptothe buildingentrancesshallbedoneindirectburied underground cable trenches as per IS 1255/NEC 2023. Necessary cable pull pit shall be provided at the entry/exit points of the building.

RoadCrossing

Cablesatroadcrossingshall beinstalledinRCCDuctswithaminimumcover of1000mmfromtop of road level. There shall be cable pull pits connecting the RCC duct at either ends of the road crossings.

Cablesofdifferentcategoriesshallbeinstalledinseparatetraysandmaintainsatisfact oryclearances for safety and to reduce the possibility of electrical interference. The following Table details the distances in mm that shall be maintained between the different categories of cables.

TableofSeparationDistancesbetweendifferentCategoriesofCable.

Cable Category	MV Power	LVPower	C&I/Protection
MVPower	Notspecificbutshall suit de-rating factor	300	600
LV Power	600	Notspecificbutshall suit de-rating factor	300
C&I/Protection	600	300	Notspecificbutshall suit de-rating factor
Gas/Watermain	300	300	300

(f) CableNumbering

All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosionresistantlabel.Cablesofdifferentcategoriesshallbetaggedwiththefollowingsubscripts and a three-digit number.

- MVpower MV-P___
- LV power P_ _ _
- Control C__ _
- Instrumentation I___
- Protection PR___
- T_ __

Telecommunication

BuildingServices

(a) Lighting

AllinternalandexternalareasshallbeprovidedwithLEDlighting.Corrosiveprooflights shallbe considered in Battery Room. The illumination levels to be achieved shall be as follows:

IlluminationSystem

LatestversionofrelatedISstandards,NBC(NationalLightingCode),NationalLightingCode(NLC) and relevant international codes shall be referred for designing Illumination for different areas.

AlllightingdesignshallbecarriedoutonDIALuxlatestversionorOEMspecificsoftware.

Thebasisofdesignshallbebasedonthefollowinglightingengineeringcriteria,asperrelevant standards or specified herewith:

a) Lightingluxlevel
b) Luminancedistribution

c) Glarerestriction
d) Directionofincidenceoflightandshadoweffect

e) Colourappearanceandcolourrenderingofthelightsource

f) Uniformity

SelectionofLuminariesandIllluminationLevel:

Thefollowingluminariesshallbeprovidedforvariousareasinordertoachievetheaverage luminance as per various relevant lighting standards or those indicated below:

Sl. No.	Area	Typeof LightFittings	Lux
1	Pumphouse	SurfaceMountedIndustriallED batten/LoworMediumorHigh Bay LED	250 Lux
2	Battery room	IndustrialtypeLEDbatten (Corrosion proof)	150 Lux
3	Machineryservicearea	IndustrialtypeLEDbatten	250 Lux
4	Officesandconferencerooms	LEDSurfacemounteddecorative down lighter fitting with polycarbonate cover	300 Lux
5	Switchgearroom/ MCC,DG room	IndustrialtypeLEDbatten	250 Lux
6	Controlrooms/SCADAroom	LEDSurfacemounteddecorative down lighter fitting with polycarbonate cover	300 Lux
7	Chemicalandgeneral stores	IndustrialtypeLEDbatten	150 Lux
8	Chemicalplant room	Anti-corrosionIndustrialLED batten	250 Lux
9	Allotherindoorareas	IndustrialtypeLEDbatten	100 Lux
10	Outdoorplatformsandwalkways	LEDBollardposttopsand Uplighter	50 Lux
11	Buildingentrance	LEDSurfacemounteddecorative down lighter fitting with polycarbonate cover	100 Lux
12	Outdoorplant areas	LEDFloodlights	20 Lux
13	Outdoortransformer yards - General - On equipment	IndustrialtypeLEDbatten	 20 Lux 30 Lux
14	Roads(secondary)	IndustrialtypeLEDbatten	20 Lux

EnergyEfficientCeilingfanswithBEEStarlabelledofBLDCtypeshallbeprovidedinoff ices, control rooms and they shall be connected to local lighting circuit.

Theinternallightinginstallationshallbeinstalled usingsinglecore,PVCinsulatedcoppercable enclosed in galvanized iron / PVC conduit. Lighting in external areas shall be installed using multicore armoured cable.

Conduitsshallbe

ForPlantBuildings&PumpHouse:

SurfaceExposedSteelConduitonceilingwithverticaldropsas below

- Plant RCC Building - Concealed uPVC conduit for drop down from ceiling to switch/socket level.
- PumpHouse–Surfacesteelconduitfordropdownfromceilingtoswitch/socketlevel.
- ForChlorine/

Chemicalbuildings,PVCconduitsshallbeused. For

Chemical/Chlorine Buildings & Pump House:

SurfaceExposedPVConceilingwithverticaldropsasbelow

- PlantRCCBuilding-PVCconduitfordropdownfromceilingtoswitch/socketlevel.
- PumpHouse–PVCconduitfordropdownfromceilingtoswitch/

socketlevel. Control Building:

- RoomswithFalseceiling–Surfacedsteelconduitaboveceiling&concealeduPVCconduit fordropdown.
- Rooms Without false ceiling- Surfaced steel conduit on ceiling & concealed uPVC conduitfor drop down.

OfficeBuilding:

- ConcealeduPVCconduitinceilingandverticaldropdown.

Followingfactorsshallbeconsideredwhilearrivingattheutilizationfactortodetermi nethenumber of fixtures for each area/building:

a) MaintenanceFactor
   - IndoorAreaLightingwithLEDLuminaire : 0.7
   - OutdoorAreaLightingwithLEDLuminaire : 0.6

b) ReflectionfactorforIndoorLightingtobeconsideredareas follows:
   - Ceiling : 0.5
   - Walls : 0.3
   - Floors : 0.1

c) However, Reflection factor can be selected based on the Color of the wall and Ceiling as given below:

- Whiteandverylightcolors : 0.7
- Lightcolors : 0.5
- Middletints : 0.3
- Darkcolors : 0.1

d) Roomindexatapplicablesurfacereflectionfactorsneedtobe considered.

e) Theworkingplaneshallbeconsideredat 0.75mfromthefloorlevel.

f) UniformityfactorshallbeconsideredasperNationalLightingcode/NBC/IScode.

ThepowersupplyforlightingshallbedistributedfromLightingDistributionBoardsand feeder pillars.

Forstreetlighting,cablingshallbedonewith4Carmouredcablesuchthatalternatefixtures arein different phases.

Streetlightingshall beCentralized,solar powersupplysystemsuitableforpowersupplytorequired number of streetlights to illuminate the complete treatment facility. Necessary interlocks shall be provided between main supply and solar supply in such way that solar energy shall be used always and switchover to EB source automatically when there shall be no solar energy available.

Solar module shall convert solar energy into electrical energy and store into the battery. During the night-timestoredenergyshallbeconvertedtoACusingefficientinverterandshallbesupplied tothe streetlights. The system shall be powered from the normal grid supply in case of cloudy days or in case of insufficient day light to charge the battery. Roof of "**ADMIN BUILDING or ANY HIGHEST BUILDING"** of ISPS area can be used for installation of solar cells.

(b) EmergencyLighting

Self-contained chargeable type emergency luminaires shall be provided to maintain minimum illumination level of 5 lux. These luminaires shall automatically illuminate in the event of a power failureandprovideaminimumleveloflightingfor approximately3hours.Theyshallautomatically recharge on the return of mains power.

Emergency lighting shall be provided outdoor, on platforms and inside buildings, using integral batteries.Theemergencylightsshallbestrategicallylocatedalongpre-definedescaperoutesfrom various areas.

(c) Ventilation&ExhaustFans(3 phase)

Variable speed ventilation ceiling fans & exhaust fans shall be provided in offices and switchgear rooms as per requirement. One BEE star rated energy

efficient Ceiling fan of 48” size shall be providedforeach10m^2orparttherеofoftheareaconcerned.Ceilingfansshallbeconnectedtothe local lighting circuit.

(d) SmallPower Outlets

Switchedsinglephasethreepin6Aand16Areceptaclesshallbeprovidedthroughout.Inofficesand control rooms they shall be modular decorative type and industrial type in all other areas for single and three phase sockets. All outlets for domestic pump, dewatering pump, submersible sump pump shall be provided with local starter panel or control cubicle. All metal clad sockets shall be provided with suitable metal clad plug.

Unlessrequiredtobeprovidedingreaternumberstopowerspecific Plantitemsthenumberofsuch outlets shall be as follows:

- 6 Atype oneoutletper5morpartthereofofperimeterinofficesandlaboratories
- 6 Atype oneoutletper20morpartthereofofperimeterinallother areas
- 16Atypeoneoutlet per20morpartthereofofperimeterinofficesandlaboratories
- 16Atypeoneoutlet per20morpartthereofof perimeterinall otherareas.

Emergency6/16AConveniencesocketoutletsfedfromELDB(fedfromUPS)shallbeprovidedin

- Receptionareas
- ControlRoom
- EngineeringRoom
- MeetingRooms

(Note:AllDCS/SCADA/communicationProcessrelateddesignshallbeusingUPSpower)

(e) 3-PhasePowerOutlets

32A switched (MCB) three phase and neutral receptacles shall be provided in plant areas where appropriatei.e.,adjacenttoareaswherefloodingislikely(topermittheuseofportable sumppumps) or where other portable equipment is likely to be used in the operation of the treatment plant. Ten such outlets at various locations throughout the treatment plant shall be considered.

Thelocationofoutletsshallbeapprovedbytheengineer.Thespacingof6Aand16Aoutlets shall be arranged to suit the intended location of equipment, desks etc.

Receptaclesforoutsideareasshallhaveadegreeofprotectionof IP65.

Earthing&LightningProtection

a) Theearthingsystemshall be designed accordingto IS 3043, NEC 2023, NBC 2016, IEEE 80, BS 7354, 7430 or relevant IS/IEC standards.

b) Earthingsystemshallbeadesignedarrangement of aninterconnected mesh ofsuitablesize of earth conductors and electrodes buried below ground at the depth mentioned in IS 3043-2018 and connected to all the metallic exposed and accessible to humans but not intended to carry normal current, parts of the equipments which are vulnerable to live accidentally, whichwould cause irreparable damage to the equipment and serious danger to human life, if remain live at high potential beyond a certain safe period of time.

c) Earthgridshallprovide

- Anequipotentsurfacetolimitthepotentialgradientattheearth’ssurface.

- A low impedance path for the fault current to the earth thereby avoid rise of potential to dangerous level and ensure fast clearance of earth faults by protective devices.

d) Anearthingsystemcomprisingearthelectrodesandconductorsshallbeestablishedseparately for each building / structure and these networks shall be interconnected.

e) Earthinginstallation inside a buildingshall be carriedout byequipotential bondingwith Main EarthingTerminal (MET). All the external earthingterminals of the switchboards/distribution boards (or) MET of the switchboard/distribution board; all protective conductors of exposed conductive parts are connected to Main Earthing Terminal (MET). All extraneous conductive parts, incoming metallic service pipes, are also connected to main MET. Further this main MET is connected to earth electrodes by Earth conductor as per design of the supply system.

f) Theearthingsystemshallbe designedto give a combined earth resistance valueof not greater than 1 ohm. In order to be sure of obtaining suitable final values, soil resistivity shall be measuredandrecordedatthe varioussitelocationsduringthedetaildesignphaseofthework.

g) In outdoor substation areas where the main earth electrode conductors will be located, ensure potential gradients occurring at the surface during fault conditions are kept within allowable limits.

h) In outdoor transformer yards, substations & switchyards, crushed rock (min. 10 cm) orgravels (50mm size) in entire area shall be provided to increase contact resistance between person’s foot and earth surface and thus provide safer step and touch potentials.

i) Along with the main grid conductors, sub-grid conductors and risers for equipment earthing shall be preparedandlaidat proper locations. Depthoftheearthingconductorshall beat least 600mm below final grade level (FGL). Earthing conductors around buildings shall be buried at 1.5m from outer boundary of the buildings. In outdoor yards & switchyards, main earth conductor shall be buried 1.0 m outside the fencing perimeter.

j) Earth conductor entering a building at below grade level, water stopshall be provided to avoid anyseepage ofwaterinsidethe building. Connection fromearth gridtoequipment shall be done by short and direct leads free from Kink and splices.

k) Earthing conductor embedded in concrete shall have atleast 50mm concrete cover. Earth conductor shall be passed through Hume pipes for

road crossings.

l) Light fixtures, conduits, ceiling fans, switches, sockets, power receptacles, JBs, streetlight poles, panels shall be earthed with separate earth conductor. RCCB/RCD shall be provided in lighting circuits.

m) Connection between main grid and equipment earthing grid and between main grid/sub-grid conductors shall be welded or brazed type. Steel to copper and copper to copper connections shall be brazed type. Steel to steel connection shall be done by electric arc welding with low

hydrogen content electrode. For prevention of rust the welds or brazed connections shall be treated with Red Lead and thickly coated by black bituminous paint/compound. All brazing shall be done by oxi-acetylene torch flame.

n) Metallic sheaths, screen and armour of all multicore power/control cables shall be earthed at both, equipment, and source/switchgear ends.

o) Earthing of Computer and Electronic System: Safety earthing and zero signal reference ground should be provided for computer and electronic systems as per BIS code/approved specification/drawings.

p) Earth conductor crossing through wall or floor slab shall be routed in GI conduit or HDPE pipe sleeve. These sleeves shall be waterproof/bitumastic compound or by fireproof sealant.

q) Materialsusedforearthelectrodesshallbedesignedtosuitthegroundconditio nsandshallbe either plain mild steel or galvanized steel or copper coated steel.

r) All the electrical equipment, frames and mechanical apparatus shall be provided with designated grounding points. Cable trays and vertical runs shall be connected to earth grid at atleast 20-meter intervals.

s) The size of the earthing leads shall be dependent on the type of equipment, maximum let through ground fault current, fault clearing time of protective device connected to it.

t) The system shall be designed for the following maximum earth fault currents. These values shall be verified at detail design phase based on the short circuit calculations in ETAP software.

- 11kV system 26.3 kA
- 415V system 50kA (Max)

u) The fault clearing time shall be considered as per IS 3043 with minimum one second for the 11 kV and 415 V systems.

v) The maximum temperature allowed for steel welded / brazed joints will be taken as 500 ^{0}C with an ambient of 45 ^{0}C. Main equipotential bonding conductors shall be galvanized steel.

w) Circuit protective conductors will comprise either the armouring of the supply cable or, for major loads such as main switchboards and large drives the supply cabling plus an additional suitably sized single core copper cable.

x) Theneutralpointofthe11/0.433kVtransformersecondarywindingswillbesolidlyearthed.

y) The need of lightning protection shall be established by calculating the

overall risk factor as per IS/IEC 62305.

z) Airterminationsystemcomprisingofrods/meshorcombinationofbothshall beprovidedand the methods used to determine the positioning of Air termination system shall be as per IS/IEC 62305.

aa) Air termination system shall be connected to the earthing system by down conductors fixed along the outer surface of building. Number & layout of the down conductors shall be as per IS/IEC 62305.

bb) Each down comer will be terminated to a separate treated test earth electrode which in turnwill be connected to plant earthing system.

cc) Testlinkwillbeprovidedintherunofeachdownconductoratapproximatel y1000mm above ground level.

LoadandElectricityConsumptionCalculation

Plant electrical load list shall be developed, for each MV/LV switchgear/MCC based on details available at various stages of project. The bidder shall submit the preliminary load list sheet along withbid(sampleformatoftheloadlistisattachedunderTechnicalScheduleXII).Thelo adlistshall be updated on regular basis during the design stage of the project and shall form the basis for provision of the transformer and diesel generators capacity.

Theloadlistshallincludeandclearlyidentifythefollowingminimumdetails:

- Continuous,intermittent,andstandbyloads
- Normal,&critical(ACUPS,DC,oremergency)loads
- Loadanddiversityfactors,powerfactorsofindividualloads,efficienciesofelect ricalequipment, like motors; and
- Startingmethod(PowerFeeder,DoL/StarDelta/VFD/Softstartingetc.)
- Continuous Working load (kW/kVA) and Peak Working load (kW/kVA) for individual loads and total plant.

Thepeakloadscalculatedfromthisloadlistformthebasisforvariousequipmentsizingl ike transformers, switchgears, DG set, UPS, cables etc.

Asummarysheetmustbeincluded intheloadlistindicatingloadsatvariousswitchboards (PCC/MCC/DG PCC), DG and transformer ratings.

MVMetalEnclosedSwitchboard/MVVCBPanel

Sr. No.	**Description**	**Unit**	**TechnicalParticulars**
12.6.1	Make		AsperPreferredMa kes/ ManufacturersofPa rt-6, General requirement.
12.6.2	Type		AsperSpecification/ Installation Outdoor
12.6.3	ApplicableStandards		AsperSpecification

Sr. No.		Description	Unit	TechnicalParticulars
12.6.4		Quantity	No.	(*)
12.6.5		**SwitchgearcubiclesandBus bar ratings**		
	(a)	Ratedvoltage,phases,andfrequency		11kV,3phase,50 Hz Resistance earthed12 28 75
	(b)	SystemNeutral Earthing		
	(c)	Maximumsystemvoltage	kV	
	(d)	One-minutepowerfrequency withstand voltage	kV (rms)	
	(e)	12/50μsecimpulsewithstandvoltage	kV (peak)	
	(f)	Shortcircuitwithstand		
		(i)Shorttime(1sec)atrated voltage	kA(rms)	26.25
		(ii)Dynamicrating	kA(peak)	65
	(g)	Referenceambienttemperature	℃	45°C
	(h)	Maximum temperature of bus bars droppers'connectorsandcontactsat continuous current rating under site reference ambient temperature	℃	Non-silver-platingJoints:90℃ Silverplatingjoints:105 ℃
	(i)	Continuouscurrentratingofbus bar	A	(*)
	(j)	Busbar material		Copper
	(k)	Busbar Insulation		Fullyinsulatedbyencapsulation in epoxy resin with mould caps protecting all joints
	(l)	Cableentry		Bottom
	(m)	CabletypeforIncoming and		11kV(UE),XLPEAluminium

Sr. No.		Description		Unit	TechnicalParticulars
		Outgoingfeeders			conductorwithGIarmouring
12.6.6		**Switchgearconstructional Requirement**			
	(a)	ThicknessofsheetsteelFrame, Frame enclosures, doors, covers and partitions		mm	Frame–2.5minimum, Doors/Covers/ partitions–2.0 minimum Glandplate-3mm
	(b)	Degreeof protection			IP4Xforpanelenclosure& busbar&IP52formetering compartment. SuitableforinstallationOutdoor
	(c)	Colourfinish shade			Interior -Glossywhite Exterior- Lightgreysemi- glossy shade 631 of IS:5
	(d)	Earthingbus	i)Material		Copper(runthroughout the panel)
			ii)Size	mmxmm	(*)
	(e)	Earthingconductor	i)Material		GSFlat
			ii)Size	mmxmm	(*)
12.6.7		**Breaker Particulars**			
	(a)	Circuitbreakertype			3 pole, Vacuum draw out type, truck mounted with Surge Suppressor,tripfreemechanism & anti pumping feature
	(b)	Voltage,phases,andfrequency			12kV,50Hz,3Ph
	(c)	Ratedoperatingduty			O–0.3sec. –CO– 3min-CO

Sr. No.		Description	Unit	TechnicalParticulars
	(d)	Ratedcurrentatreferenceambient temperature (ii) Incomingbreakers	A	(*)
		(iii)Outgoingbreakers	A	(*)
	(e)	Ratedbreakingcapacity	kA(rms)	26.25
	(f)	Ratedmakingcurrent	kA(peak)	65
	(g)	Shorttimecurrentwithstandfor 1sec duration	kA(rms)	26.25
	(h)	Totalbreaktime	milliseconds	Lessthan 50
	(i)	Operatingmechanismtype(Normal)		MotorspringChargedstored energy type for closing and tripping
		Operatingmechanismtype (Emergency)		ManualSpringChargedfor closing and tripping
	(j)	Minimumno.ofauxiliarycontacts		6NO+6NC
	(k)	Withstandtest voltage		
		(i)One-minutepower frequency	kV (rms)	28
		(ii)1.2/50μsecimpulse	kV (peak)	75
	(l)	Auxiliarycontrol voltage (i)Forclosing/tripping coil		110 VDC
		(ii)Forspringchargingmotor		240 VAC
		(iii)Forspaceheatersandlighting		240 VAC
		(iv)Permissiblevariationinoperating voltage of closing & tripping coils		85to110%forclosing coil 70to110%fortripping coil
	(m)	Anti-pumpingfeature		Tobeprovided

Sr. No.		Description	Unit	TechnicalParticulars
	(n)	Latchingrequirement		Trip free
12.6.8		**Current Transformers**		
	(a)	Type		Castresinwindowtype
	(b)	Classof insulation		ClassEor better
	(c)	Ratedcurrentratioandburden (i) Incomersandbuscouplers		(*)
		(ii)Outgoingfeeders		(*)
	(d)	Accuracyclass (i)Metering		1.0
		(ii) Protection		5P20andPSforcoreconnected to Restricted Earth fault relay
	(e)	Shorttime1seccurrentrating	kA(rms)	26.25
	(f)	Dynamicrating	kA(peak)	65
12.6.9		**VoltageTransformers**		
	(a)	Type		Castresin
	(b)	RatedVoltage (i)Primary	V	11000/√3
		(ii)Secondary–S1	V	110/√3,110/√3
	(c)	Methodofconnection (i)Primary–P		Star,earthed
		(ii)Secondary–S1		Star,earthed
	(d)	Application– S1		Meteringand protection
	(e)	Rated burden	VA	(*)
	(f)	Accuracyclass		Metering1.0 Protection3P
	(g)	Ratedvoltagefactor		1.2

Sr. No.	Description	Unit	TechnicalParticulars
	(i)Continuous		
	(ii)Short time		1.5
(h)	Insulationclass		ClassEor better
12.6.10 (a)	**Meters** Make		AsperPreferredMakes/ ManufacturersofPart-6, General requirement.
(b)	AccuracyClass		
12.6.11	(i)IndicatingMeters		Class1.0orbetter
	(ii)EnergyMeter		Class1.0orbetter
12.6.12	**ProtectiveRelays**		
	Type		NumericalType
	Auxiliarysupply		110VDC
12.6.13	**Annunciations**		
	AnnunciationsforMetalenclosedSwitch board		
(a)	Followingalarmannunciationshallbeprovidedonthe11kVMetalEnclosed Switchboard Incoming feeders (i) Trippedon fault (ii) O/C&E/Foperated (iv) Tripcircuitsupervision unhealthy (v) DCfail (vi) ACfail		
(b)	ForeachOutgoingtransformerfeedercircuitbreakers (i) Trippedon fault (ii) O/C&E/Foperated (iii) Buchholz,WTI,OTItrip (iv) Tripcircuitsupervisionunhealthy (vii) DCfail (v) ACfail (vi) Buchholz,WTI,OTI,Oillevellowalarms		
(c)	ForOtherOutgoingfeeders (i) Trippedonfault		

Sr. No.	Description	Unit	TechnicalParticulars
	(ii) O/C&E/Foperated (iii) Tripcircuitsupervisionunhealthy (iv) DCfail (v) ACfail		
(d)	For Bus PT (i) Undervoltage trip (ii) DCfail (iii) ACfail		
(e)	Spare windows: 2Nos. Minimum.		
12.6.14	**CubicleComponents**		
	Each11kVcircuitbreakercubicleshallbeprovidedwiththefollowingminimum standard accessories		
(a)	Onecontrolswitch‘trip-neutral-close’springreturntoneutralposition		
(b)	Onecontrolselectorswitch‘Local-Off-Remotestay-put’type		
(c)	LEDIndicatinglamps (i)‘Red’forbreakerin‘On’indication (ii)‘Green’forbreaker‘Off’position (iii) ‘Amber’forbreakertrippedonfault‘White’fortripcircuit healthy (iv)‘Blue’forbreakerin‘Service’position (v)‘White’forbreaker in‘Test’ position (vi)‘Blue’forbreakerspring‘Charged’ (vii) ‘Amber’forDC fail (viii) ‘Amber’forACfail (ix)‘Red,’’Yellow,’’Blue’forsupplyhealthyforincomers. (x)‘Yellow”for‘Readyto close’		

Sr. No.	Description	Unit	TechnicalParticulars
(d)	Mechanicaltrippushbuttontotripthebreakerwhencontrolsupplyislost.The push button shall be shrouded type		
(e)	Oneelectricalanti-pumpingrelay		
(f)	DoublepolecontrolsupplyMCBoneeachforAC&DCcontrolsupply Cubicle space heater of adequate capacity with thermostat		
(g)	240V,1Phase,50Hz,15/5A,5pinreceptaclewithswitch		
(h)	Cubicle lamp with door interlock switch		
12.6.15	**AuxiliaryA.C.Supply**		
	240V, 1Ph, 50Hz supply shall be made available to each cubicle of 11kV Metal EnclosedSwitchboardsseparatelyforprovisionoffollowingbyprovidingcontrol transformer		
(a)	Springchargingmotor		
(b)	Cubiclespaceheaterwiththermostat		
(c)	Cubiclelamp		
(d)	240V,1Ph,50Hz15/5A5pinreceptaclewithswitch		

DistributionTransformers

Sr. No.	Description	Unit	TechnicalParticulars
12.7.1	Make		As per Preferred Makes/ ManufacturersofPart-6,General requirement.
12.7.2	Type		AsperSpecification
12.7.3	ApplicableStandards		AsperSpecification&IS1180 latest amendment
12.7.4	Rated output	kVA	(*)
12.7.5	Quantityrequired	Nos.	(*)

Sr. No.	Description	Unit	TechnicalParticulars
12.7.6	Transformerlocation		Outdoor
12.7.7	Noloadtransformerratio	kV/kV	11/0.433
12.7.8	Numberof phases		3
12.7.9	Rated frequency	Hz	50
12.7.10	Impedanceatalltaps Standard losses	% Watts	ValueasperIS1180 LatestAmendment-4
12.7.11	Numberofwinding/materialsof conductor / Insulation class		Two/Copper/classA
12.7.12 (a) (b)	Methodofconnection MVwinding		 Delta
	LV winding		Star
12.7.13	Vectorgroup		Dyn11
12.7.14	LV Neutral		Solidlyearthed
12.7.15	Typeof cooling		ONAN
12.7.16	Tapchanger		Full capacity, microprocessor baseOn-loadtypeonMV side withlocalmarshallingboxa nd Remote Tap Changing panel
12.7.17	Taprange	%	+5%to -15 %
12.7.18	Tapstep	%	2.5 %
12.7.19 (a) (b)	Terminalconnec tion MV terminals LV terminals		 Cable box suitable to 11kV UE, XLPE,Al.Conductor,armour ed cable of size (*) Cable box suitable for 1100V XLPE,Al.Conductorarmour ed cables (*) Fortransformerratingsgrea ter

Sr. No.	Description	Unit	TechnicalParticulars	
			than or equal to 1000kVA,LV side should be suitable for terminationofNon-Segregated Aluminium Bus duct (*)	
12.7.20 (a) (b)	CurrentTransfo rmer On LV OnLVNeutral		(*)	
12.7.21	LVNeutral earthing		The neutral of the star-connected windingshall be brought out toa separate bushing terminal. The neutralbushingshallbepro vided on the tank side to facilitate lead of the earth conductor (*) down to the ground level. For transformers 1000 kVA and above,tankmountedEpoxy resin cast insulators shall be provided for supporting the neutral earthing bar of required section, along its run from the neutral bushing to ground-level. Neutral shall also be extended to cable box/busductflangeas applicable.	
12.7.22	InsulationofWindings		H.V.	L.V.
(a)	One-minute power frequency withstandvoltage(dryandw et)	kV (r.m.s)	28	3.0
(b)	1.2/50microsecondfullwave impulse withstand voltage	kV (peak)	75	-

12.7.23	Insulationofbushings		H.V.	L.V. (Lineand Neutral)
(a)	RatedVoltageofbushing	kV	17.5	1.1

Sr. No.	Description	Unit	TechnicalParticulars	
(b)	One-minutepowerfrequency withstand voltage	kV (r.m.s)	38	3.0
(c)	1.2/50microsecondfullwave impulse withstand voltage	kV (peak)	95	-
(d)	Minimumcreepage distance	mm	25mm/ kVon 17.5kV	25mm/ kVon 3kV
12.7.24	Vacuum withstand capability of transformermaintankwithbushings, radiations, fitting and accessories.		AsperIS1180	
12.7.25	Inspection		As per IS 1180, Complete Routinetestandoneeachfrom TypetestandSpecialtesttobe indicated in QAP for witness	

415VMetalEnclosedSwitchgears(PCC)/MCC

Sr. No	Description	Unit	TechnicalParticulars
12.8.1	Make		AsperPreferredMakes/ ManufacturersofPart-6, General requirement.
12.8.2	Type		AsperSpecification
12.8.3	ApplicableStandards		AsperSpecification
12.8.4	Quantity	No.	(*)
12.8.5	**415VSwitchgearandBusbar Ratings**		
(a)	Ratedvoltagephaseandfrequency		415V,3 Ph, 50Hz
(b)	SystemNeutral Earthing		Solidlyearthed

(c)	Maximumsystemvoltage	V	476
(d)	One-minutepowerfrequency		

Sr. No	Description	Unit	TechnicalParticulars
	voltage		
	i)Powercircuits	V	2500 (rms)
	ii)Controlcircuits	V	1500 (rms)
	iii)Aux.Circuitsconnectedto Sec of CTs	V	1500 (rms)
(e)	Continuous current rating of Busbars under site reference AmbientTemperatureandtype&material	Rating Material	(*) Copper
(f)	Busbarinsulation		Fullyinsulatedencapsulationin epoxy resin with moulded caps protecting all joints
(g)	ReferenceAmbientTemperature	°C	45
(h)	MaximumTemperatureofBusbars, Droppers and Contacts at Continuouscurrentratingundersite ambient temperature	°C	85forbusbarsandnon-silver- plated joints 100forsilverplatedjoints
(i)	ShortCircuitcurrentwithstand for Busbars and droppers (i)Shorttime1sec	kA(rms)	50
	(ii)DynamicRating	kA(peak)	125
12.8.6	**SwitchgearConstructional Requirement**		
(a)	Typeof Construction		Singlefrontfixedtype(Except forairCircuitBreakers,which shall be draw out type). Constructionfeaturesshallbe as per specification.
(b)	Thicknessofsheetsteel (i)Frame,Frameenclosures,doors, covers and partitions	mm	CRCA–2.0
(c)	Degreeof protection		IP54indoorandIP55for outdoor

(d)	Colourfinish shade		Interior:Glossywhite
			Exterior:Lightgreysemi

Sr. No	Description		Unit	TechnicalParticulars
				glossyShade631ofIS-5
(e)	Earthingbus	Material		Copper(runthroughoutthe panel)
		Size	mmxmm	(*)
(f)	Earthingconductor	Material		GS
		Size	mmxmm	(*)
(g)	Minimumclearancesinairofl ive parts (i)PhasetoPhase		mm	25.4
	(ii)PhasetoEarth		mm	25.4
(h)	(i)Cableentry (ii)Cableentryforpanelsabo ve wet well			Botto m Top
12.8.7	**InstrumentationTransformers**			
(a)	Currenttransformer			
	(i)Ratio			(*)
	(ii)Burden		VA	(*)
	(iii)AccuracyClass			1.0
(b)	Voltagetransformer			
	(i)Ratio			(415V/√3)/(110V/√3)
	(ii)Burden		VA	50
	(iii)AccuracyClass			1.0
(c)	AuxiliaryA.C.Supply			240V, 1Ph, 50Hz supply shall be made available to each cubicle of 415V Metal Enclosed Switchboards separatelybyprovidingcontrol transformer

PowerCapacitorandControlPanel

Sr. No	Description	Unit	TechnicalParticulars
12.9.1	**General**		
(a)	Make		AsperPreferredMakes/ ManufacturersofPart-6, General requirement.
(b)	Type		AsperSpecification
(c)	ApplicableStandards		AsperSpecification
(d)	Quantity	No.	(*)
(e)	Rated Capacity	kVAR	(*)
(f)	Ratedsupplyvoltage	V	415
(g)	Ratedfrequencyandphases		50Hz,3Phase
(h)	ReferenceAmbienttemperature	^{o}C	45
(i)	Cablegland required		Yes
(j)	Typeof cable		1.1kV,XLPE,Al.Conductor
(k)	Sizeof cable		(*)
(l)	Cableentry		Bottom
12.9.2	**ConstructionalRequirement**		
(a)	Thicknessofsheetsteel i)Frame,Frameenclosures,doors cover and partition	mm	CRCA2.0
(b)	Degreeof protection		IP42
(c)	Colourfinish shade		Interior:Glossywhite Exterior:LightGreySemi Glossy Shade 631 of IS-5
(d)	Mainbusbarsandsize		Copperand (*)
(e)	MaximumTemperatureofBusbars, Droppers and Contacts at Continuouscurrentratingundersite ambient temperature	^{o}C	85forbusbarsandnon-silver- plated joints 100fornon-silver-platedjoints
(f)	Earthingbus Material		Copper(runthroughoutthe panel)

		Size	mmxmm	(*)
(g)	Earthing	Material		GS

Sr. No	Description		Unit	TechnicalParticulars
	conductor			
		Size	mmxmm	(*)
12.9.3	**Design Requirement**			
(a)	Insulationlevel		kV (rms)	3.0
(b)	Capacitorbankconnection			Delta
(c)	Shortcircuitwithstandforbusbars i)shorttime(1sec)		kA(rms)	50
	ii)Dynamic		kA(peak)	125
(d)	Typeof switching			Automatic switching responsive to power factor throughpowerfactorsensing relay
(e)	Switchingsteps			Minimum8 steps
(f)	SwitchandRatingofcontactor			TosuitkVARofunit (switching duty)
(g)	IncomerMCCBcurrentrating			To suit rated capacity of capacitorbanks(switching duty)
(h)	O/Lcapacityof capacitors			30%ofratedcapacityasperIS
(i)	O/Vcapacityof capacitors			10%ofratedvoltageasperIS
(j)	Protections			O/V,U/VandO/L

DieselStandbyGeneratorSets

Sr. No.	Description	Unit	TechnicalParticulars
12.10.1	**General**		
(a)	Type		SilentSetwithAMF
(b)	SoundLevelat1metredistance		< 75 dB
12.10.2	**Alternator**		

Sr. No.	Description	Unit	TechnicalParticulars
(a)	Manufacturer		As per Preferred Makes/ ManufacturersofPart-6,General requirement.
(b)	Type		Salientpole,Revolving field, Brushless type
(c)	Rating	kVA	(*)
(d)	Voltage	V	415
(e)	Frequency	Hz	50
(f)	OverloadCapacity		10%overloadfor1hourinany12 hours
(g)	Insulation		ClassHwithClassFtemperature rise
(h)	Shortcircuitcurrent		3timesfullloadcurrentfor10sec
(i)	Degreeof protection		IP23withIP54forterminalbox
(j)	Current	A	(*)
(k)	PowerFactor		0.8
12.10.3	**DieselEngine**		
(a)	Manufacturer		As per Preferred Makes/ ManufacturersofPart-6,General requirement.
(b)	Type		Fourstroke,directinjection, turbocharged
(c)	Rating	kW	(*)
(c)	Speed	rpm	1500
(d)	FuelSpecification		Aspermanufacturer’sstandard
(e)	OverloadCapacity		10%overloadfor1hourinany12 hours
(f)	Classof governance		ClassA2
12.10.4	Dayoiltankcapacitywithall	Litres	990

Sr. No.	Description	Unit	TechnicalParticulars
	necessary connections for fuel flowfromdaytanktoDGengine with level sensors, inlet, outlet piping with valves and accessories etc. Complete		(DGSetratinglessthan200kVA fuel storage shall require to run minimum10hourscontinuously)

VariableFrequency Drives

Sr. No.	Description	Unit	TechnicalParticulars
12.11.1	Make		AsperPreferredMakes/ ManufacturersofPart-6, General requirement.
12.11.2	Typeof Drive		InverterControlledA.CDrives
12.11.3	Ratedvoltage,frequency,and phases	V	415V,50Hz,3Phase
12.11.4	Variationinvoltage	V	415V±10
12.11.5	Variationinfrequency	Hz	50Hz±5
12.11.6	Typeof Duty		100% continuous, 150 % overload for 2 minutes once in period of 24 hours, 200 % overloadfor10secondsoncein period of 24 hours
12.11.7	DesignAmbientTemperature	^{0}C	45^{0}C
12.11.8	OverallHarmonicLimitation (THD_i)		Lessthan5% (includingcurrent and voltage harmonics)
12.11.9	Application		AsperClause12.14.4of Part 12–ParticularElectricalPlant Requirements
12.11.10	Interfaces		Serial/ Profibus

Battery

Sr. No.	Description	Unit	TechnicalParticulars
12.12.1	Make		AsperPreferredMakes/ ManufacturersofPart-6, General requirement.
12.12.2	Typeof battery		Ni-Cd
12.12.3	ApplicableStandards		AsperSpecification
12.12.4	Numberofbatterybanksrequired		(*)
12.12.5	Ambientconditions		Min. Temp. 25°C
			Max.Temp 45°C
12.12.6	D.C.system voltage	V	110±10%
12.12.7	Amperehourcapacityofbatteryat 27 Deg. C at 5-hour rate to give final cell voltage of 1.16 volts/cell	Ah	Asperthe Requirement
a	Momentaryload/duration	A	TobefurnishedbytheBidder
b	Emergencyload/duration	A	
c	Continuousload/duration	A	
12.12.8	Nominalvoltage	V	1.2Vpercell
12.12.9	Cellvoltage-initial/final	V	1.42/1.14V
12.12.10	Numberofcellsperbankrequired to give rated voltage	Nos.	(*)
12.12.11	Numberofsparecellsperbank	Nos.	(*)
12.12.12	Mountingarrangement		Multi-tier
12.12.13	Chargingmethod		Float cumboostcharging

BatteryCharger

Sr. No.	Description	Unit	TechnicalParticulars
12.13.1	**General**		
(a)	Make		AsperPreferredMakes/ ManufacturersofPart-6,

Sr. No.	Description	Unit	TechnicalParticulars
			Generalrequirement.
(b)	ApplicableStandards		AsperSpecification
(c)	Type		FloatandFloatcumBoost Charge
(d)	Numberrequired	Nos.	(*)
(e)	RatedOutputvoltage(DC)	V	110
(f)	Rated Output	kW	(*)
(g)	DCSystemEarthing		Unearthed
(h)	Voltageregulationfromnoloadto rated load	%	±1
(i)	AmbientDesignTemperature	DegC	45
(j)	ACrippleinDCoutputvoltageat rated continuous load		Lessthan 1%
(k)	Typeof rectifier		SCR,fullwavefullycontrolled
(l)	Transformer		Copperdoublewounddrytype with class-F insulation
(m)	Float/Tricklechargingcurrent of battery	mA	Aspermanufacturer
(n)	BoostChargingCurrentofBattery (Maximum)	A	Aspermanufacturer
(o)	BoostChargingVoltageofBattery (maximum)	V	Aspermanufacturer
(p)	MaximumTimeforBoostcharging of Battery	hr	Aspermanufacturer
12.13.2	**BatteryDetails**		
(a)	Float/Tricklechargingcurrent of battery	mA	Aspermanufacturer
(b)	BoostChargingCurrentofBattery (Maximum)	A	Aspermanufacturer
(c)	BoostChargingVoltageofBattery (maximum)	V	Aspermanufacturer
(d)	MaximumTimeforBoostcharging	hr	Aspermanufacturer

Sr. No.	Description		Unit	TechnicalParticulars
	of Battery			
(e)	Batterycapacity&no.ofcells		Ah	(*)
			Nos.	(*)
12.13.3	**ACSystemData**			
(a)	Supply	Voltage	V	415
		Phase		3
(b)	(i)VariationinsupplyVoltage		%	±10
	(ii)Variationinsupplyfrequency		%	±5
(c)	ShortCircuitlevel		kA	50
(d)	Typeof earthing			SolidlyEarthed
12.13.4	**Performance**			
(a)	DCvoltagesettingadjustment for floatcharger			±10%ofnominalvoltage
(b)	Voltagestabilisationforconstant voltage regulator			±1% of set D.C. voltage, with ACinputvariationandDCload variation from 0 to 100%
(c)	Maximumpermissiblevariation inDCvoltage(noloadtofullload)			±1%
(d)	D.C.voltagesettingadjustment forboostcharging			70%to100%ofmax.boost charging voltage
(e)	D.C.currentadjustmentforboost Charging			30%to100%ofmax.boost charging current
(f)	Currentstabilisationforconstant currentregulatorforboostcharger			±2%
(g)	Minimumpermissiblepowerfactor toratedcontinuous load			0.8
(h)	Permissibleripplecontentatrated continuousload			3% (maximum)

Sr. No.	Description		Unit	TechnicalParticulars
(i)	Relay for auto changeover from Float to boost mode to be provided (incaseoffloat-cum-boostcharger)			Yes
12.13.5	**ConstructionalFeatures**			
(a)	Thickness of sheet steel Frame, Frameenclosures,doors,covers and partition		mm	Coldrolled2.0
(b)	Degreeof protection			IP42
(c)	Colourfinish shade			Interior:Glossywhite
				Exterior:LightGreySemi Glossy Shade 631 of IS5
(d)	Earthingbus	Material		Copper
		Size	mmxmm	(*)
(e)	Earthingconductor	Material		GS
		Size	mmxmm	(*)
(f)	Cableentry			Bottom
(g)	Cable Sizes (i)Battery		sq.mm	(*)
12.13.6	(ii)DC output		sq.mm	(*)
12.13.7	(iii)ACinput		sq.mm	(*)

DCDistributionBoard

Sr. No.	Description	Unit	TechnicalParticulars
12.14.1	**General**		
(a)	Make		AsperPreferredMakes/ ManufacturersofPart-6, General requirement.
(b)	Applicablestandards		Asper specification
(c)	Quantity	Nos	(*)
(d)	DCSystemvoltage(Nominal)	V	110
(e)	DCSystemEarthing		Unearthed

(f)	AmbientDesignTemperature		Deg.C	45
(g)	Busbarmaterial,rating,and size			Copper,Rating&Size(*)
12.14.2	**DCBus Load**			
(a)	TotalcontinuousDCload		A	(*)
(b)	Shorttimeloads(Additionalto continuousloads)			
	(i)DClights/Facialamps		A	(*)
	(ii)Startingcurrentandduratio nof Largest Connected DC Motor		A	(*)
			Secs	(*)
12.14.3	**ConstructionalFeatures**			
(a)	Thickness of sheet steel Frame, Frameenclosures,doors,cove rsand partition		mm	CRCA2.0min.
(b)	Degreeof protection			IP54
(c)	Colourfinish shade			Interior:Glossywhite
				Exterior:LightGreySemi Glossy Shade 631 of IS5
(d)	Earthing bus	Material		Copper(runthroughoutth e panel)
		Size	mmxmm	(*)
(e)	Earthingconductor	Material		GS
		Size	mmxmm	(*)
(f)	Cableentry			Bottom
(g)	Cable Sizes (i)DCInput fromBattery		sq.mm	(*)
	(ii)DCoutputtoLoad		sq.mm	(*)

Cables

Sr. No.	Description	Unit	TechnicalParticulars
12.15.1	**11kV(UE)XLPEInsulatedPo wer Cables**		

Sr. No.	Description	Unit	TechnicalParticulars
(a)	Make		As per Preferred Makes/ ManufacturersofPart-6,General requirement.
(b)	ApplicableStandards		Asper specification
(c)	Cablesize selection		Asper requirement
(d)	Continuouscurrentratingwith cable laid in air/ ground under specified ambient temperature	A	(*)
(e)	Conductormaterial		Stranded,aluminium,EC grade/class 2
(f)	Conductorscreening		Semiconductingcompoundby extrusion
(g)	Insulation		ExtrudedXLPE
(h)	ScreeningonInsulation		Semiconducting compound by extrusion(non-metallic),copper tape (metallic)
(i)	Identificationofcodes		ByprovidingstripofRed, Yellow & Blue colours
(j)	Innersheath		ExtrudedPVC,typeST-2
(k)	Filler material		PVC
(l)	Armouring		Galvanisedsteelflatstrip
(m)	Outersheath		ExtrudedPVC,typeST-2
(n)	Overalldiameterofcable		TobefurnishedbytheBidder
(o)	Recommendedminimumbending radius	mm	Tobefurnishedbythebidder
(p)	Standardlengthofcableoneach drum	mts	(*)
12.15.2	**1100VGradeXLPEInsulated Power Cables**		
(a)	Make		AsperPreferredMakes/ ManufacturersofPart-6,General

Sr. No.	Description	Unit	TechnicalParticulars
			requirement.
(b)	ApplicableStandards		Asperspecification requirement
(c)	Cablesize selection		Asper specification
(d)	Conductormaterial		Stranded,aluminium/ copper,EC grade
(e)	Insulation		XLPE
(f)	Innersheath		ExtrudedPVC,typeST-2
(g)	Armouring		Galvanisedsteelflatstrip/ round wire
(h)	Outersheath		ExtrudedPVC,typeST-2
(i)	Overalldiameterofcable		TobefurnishedbytheBidder
(j)	Recommendedminimumbendi ng radius	mm	Tobefurnishedbythebidder
(k)	Standardlengthofcableoneac h drum	mtrs	(*)
12.15.3	**650/1100VGradePVCInsula ted Control Cables**		
(a)	Make		As per Preferred Makes/ ManufacturersofPart-6,General requirement
(b)	ApplicableStandards		Asper specification
(c)	Rated voltage	V	Asper requirement
(d)	Cablesize selection		Asper specifications requirement
(e)	Conductormaterial		Stranded,copper,EC grade
(f)	Insulation		PVC
(g)	Innersheath		ExtrudedPVC,typeST-1
(h)	Armouring		Galvanisedsteelroundwire

Sr. No.	Description	Unit	TechnicalParticulars
(i)	Outersheath		ExtrudedPVC,typeST-1
(j)	Standardlengthofcableoneach drum	mtrs	(*)

LightingFixturesandAccessories

Sr. No.	Description	Unit	TechnicalParticulars
12.16.1	**General**		
(a)	Make		AsperPreferredMakes/ ManufacturersofPart-6, General requirement.
(b)	Type		Asper specification
(c)	Illuminationlevelsatvarious premises		AsperBuildingServices, Clause 12.16 of Part 12-Particular electrical requirements
(d)	Normalsupplyvoltage,phase,and frequency	AC	240V,1Ph,2wire,50Hz
		DC	110V,2wire,unearthed
(e)	Variationinsupply:		
	(i)Voltage(AC&DC)	%	±10
	(ii) Frequency	%	±5
	(iii)Combinedvoltage&frequency	%	±10
(f)	Designambientairtemperature	^{0}C	45˚C
12.16.2	Luminaireterminalsuitablefor		
(a)	Indoor area		
	(i)Conductormaterial		Copper
	(ii)Cable size	Coresxmm^{2}	(*)
(b)	Outdoorarea		
	(i)Conductormaterial		Copper
	(ii)Cable size	Coresxmm	(*)

		2	

Sr. No.	Description	Unit	TechnicalParticulars
12.16.3	Luminaryearthingterminalsuitable for		
	(i)Conductormaterial		G.S.wire
	(ii)Conductor size	SWG	(*)

LightingSystemandEquipment

Sr. No.	Description	Unit	TechnicalParticulars
12.17.1	**SystemParticular**		
(a)	**Voltage**		
	(i)3Phase,4wire50Hzsystem		
	• Rated	V	415
	• Maximum	V	476
	• Oneminutewithstand voltage		2500VAC.
	(ii)D.C.system		
	• Rated	V	110
(b)	Systemshort-circuitlevel		
	(i)At415V,A.C.	kA(rms)	10
	(ii)At110V.D.C.	kA (D.C.)	6
(c)	Referenceambienttemperature	^{0}C	45^{0}C
12.17.2	**DistributionBoard/Panels**		
(a)	Main,floormounteddistribution boards		
(i)	MainLightingdistributionboard (A.C.)		
	• Make		As per Preferred Makes/ ManufacturersofPart-6,General requirement.

Sr. No.	Description	Unit	TechnicalParticulars
	• Type		Floorstanding,sheetsteel Enclosed
	• Degreeof protection		IP54
	• Busbarmaterial		Copper
	• Busbarcurrentrating	A	(*)
	• Shortcircuitcurrentrating	kA	(*)
	• Cableentry		BasedonLayoutToporbottom
	• Location		Indoor
(ii)	Emergencylightingpanel(D.C.)		
	• Make		As per Preferred Makes/ ManufacturersofPart-6,General requirement.
	• Type		Wallmounting,sheetsteel Enclosed
	• Degreeof protection		IP54
	• Busbarmaterial		Copper
	• Busbarcurrentrating	A	(*)
	• Shortcircuitcurrentrating	kA	(*)
	• Cableentry		BasedonLayoutToporbottom
	• Location		Indoor
(b)	SinglephaseDBs(SLDB), wall/structure mounting		
(i)	SLDBforindoorarea		
	• Make		As per Preferred Makes/ ManufacturersofPart-6,General requirement.
	• Type		Wallmounting,sheetsteel enclosed
	• Degreeof Protection		IP54
(ii)	SLDBforoutdoorarea		

Sr. No.	Description	Unit	TechnicalParticulars
	• Make		As per Preferred Makes/ ManufacturersofPart-6,General requirement.
	• Type		Wallmounting,sheetsteel enclosed
	• Degreeof Protection		IP55
(c)	Paint Finish		
	(iii)Colourshade:		Interior:Glossywhite
			Exterior:Lightgreysemiglossy shade 631 of IS:5
12.17.3 (a)	**StreetLightPolesandFloodLight Poles** StreetLightPolesinglearm		
(i)	TotalHeight:	m	7.5forstreetlight 3.0foroutdoorplatformlighting
(ii)	Quantity:	Nos.	(*)
(b)	FloodlightLight Pole		
(i)	Totalheight:	mts.	9
(ii)	No.Offloodlightsperpole	Nos.	(*)

EarthingandLightningProtectionSystem

Sr. No.	Description	TechnicalParticulars		
		Size	**Material**	**No.ofLeads& Quantity**
12.18.1 (a)	**MainEarthingGrid** Buriedinearth	(*)	GS	Quantityasper requirement
(b)	Buriedinfloorslabsinbuildings	(*)	GS	Quantityasper requirement

Sr. No.	Description	TechnicalParticulars		
12.18.2	**ConductorLeadsto Equipment** (Aboveground)			
(a)	Transformers			
(i)	Transformerneutraltobotto mof tank	(*)	GS	
(ii)	Frombottomof tanktoearth grid	(*)	GS	NumberofLeads Asper relevant Standards,Qua ntity asperrequirem ents
(iii)	Transformertanksand radiator bank	(*)	GS	
(b)	DieselGeneratorSet			
(i)	DGSetneutralearthing	(*)	GS	
(ii)	DGSet bodyearthing	(*)	GS	
(c)	Fencepostsandgates(Flex. braid)	(*)	GS	
12.18.3	**11kV Metal Enclosed Switchboard,415Vswitc hgear/ MCC.**	(*)	GS	
(a)	Motors			
(i)	415VMotorsabove10kW	(*)	GS	
(ii)	415VMotorsupto10 kW	(*)	GS	
(iii)	Fractionalhorsepowermotor s	(*)	GS	
(b)	**OtherItems**			
(i)	Capacitor panel, Battery charger panel, DC distribution board, MainlightingD.B,Controlpa nels and sub-lighting distribution boards	(*)	GS	
(ii)	Handrails	(*)	GS	
(iii)	Cabletrays	(*)	GS	
(iv)	Tanks	(*)	GS	

Sr. No.	Description	TechnicalParticulars		
(v)	Junctionboxes	(*)	GSwire	
(vi)	Lightingfixtures,receptacles , lighting conduits	(*)	GSwire	
(v)	Pushbuttonstations,limit switches	(*)	GSwire	
12.18.4	**Cranerail**	(*)	GS	
(a)	Streetlighting,floodlighti ng poles and junctions' boxes	(*)	GS	
(b)	Metallicnon-currentcarrying structures	(*)	GS	
12.18.5	**LightningConductors**			
(a)	AirTermination	(*)	GS	
(a)	Lightningprotectiondownco mers for building	(*)	GS	
(b)	Lightningprotectionhoriz ontal roof conductor for building	(*)	GS	
12.18.6	**Electrodes**	(*)	Heavy duty 40mm diameter GI pipe(leng th as per IS 3043)	Quantityasper requirements
(a)	Pipeelectrode	(*)		

Note:Anyrequirement/features/ provisionsnotspecificallymentionedintheSpecificationbutare necessary for trouble free and smooth operation of the Plant System shall be included.

(i) (*) – The numbers, ratings, sizes etc shall be worked out by the contractor duringexecution and to be approved by the Engineer.

(ii) Contractor shall notify the Employer for factory inspection and testing of equipment as defined in Clause 14.1.2, Materials, Plant & Equipment of Part 14, Volume -2 of the Bid document.

EndofPart-12

PART13

PARTICULARREQUIREMENTS

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PART13

PARTICULAR REQUIREMENTS
INSTRUMENTATION&CONTROL

InstrumentationSystem

Thissectionoutlinestheparticularrequirementsfortheinstrumentationsystems.Unlessspecifiedin this sectionto the contraryinstrumentation Plant provided by the Contractor and workmanship shall comply with the General Chapters of these Requirements.

Thescopeofinstrumentation,controlandautomation(ICA)worksforI**SPSatKoramangalaSports Complex** under this contract shall comprise of the design, manufacture, programming and configuration, off site testing, delivery to site, installation and erection, testing, commissioning, setting to work and provision of documentation for a completeinstrumentation, control and automation IC&A and SCADA system including the interfaces required to provide monitoring and control for a safe and efficient operation ofthe ISPS. The scope shall also include

1. ISPSPumpingProcessisFullyAuto-ModethroughControl System.
2. Complete operational data of the ISPS to be transmitted to the Central SCADA MonitoringCentre (CSMC) via redundant GPRS wireless gateway.

TheminimumscopeofworkforICAat ISPS(asperattachedP&ID)shallincludebutnotlimitedto:

ISPS:

- Design,supply,install,test andcommissionastandalonePLCbasedSCADAsystemforISPS.The system shall include but not limited to process controller including its central process unit (CPU is standalone),communicationmodules,Simplexinput-output(I/O)modules(Hotswa

ppable),control networks, operator workstations, engineering workstation and printers;

- Design,supply,install,testandcommissionfieldinstrumentationfortheentireISPS;

- Design,supply,install,testandcommissionuninterruptedpowersupplysystemtoprovideback-up supply to the entire PLC based SCADA system including field instruments
- Design,supply,install,testandcommissionInterfaceequipmenttoenablecommunicationbetween ISPS and downstream STP (if necessary) and/or Central SCADA Monitoring Centre (CSMC) located at 2nd Floor, BWSSB New Building, 11th Main, IVth T Block, Jayanagar, Bangalore;
- All ISPSPumpsareworkingunder FullyAuto-ModefromtheControl Systemaswell asManual- Mode from their Local Control Panels or Local Push Button Stations.
- Design,supply,install,testandcommissionforfieldinstrumentation.
- TheAuto-Jamremovalshallbeapplicableforeachscreensystemandthesameistobeimplemented by using control logic built into the screen control system which will be supplied by the Screen supplier. The Screen Control System data is to be integrated to ISPS SCADA / HMI System byusing hard wired communication system.

The Contractor shall be responsible for the design of each instrumentation and plant monitoring system,includingtheselectionanddesignofappropriatetransducers,transmitters,signalconditioning devices, indicators, alarm system programmable devices, communications, cable system etc. The Contractor shall take account in his design of all installation and environmental conditions prevailing at the site.

FieldInstrumentationand Control

EachfieldinstrumentshallbeoperableinlocalmodeandhavedisplayfunctionsinSCADA.The Contractor shall be responsible for providing the appropriate signals at the locations required to provide the specified control and monitoring functions.

TheContractorshallensurethatfieldmeasuringsystemsshallrespondquicklytoanychangesofthe measured process variables.

Allfieldinstrumentsshall,asfaraspracticable,bemountedinalocationthatshallbefreeof vibration and shall be powered from the instrument control system.

24Vdcpowerwiringforfieldinstrumentsshallbeindividually fusedandprovidedwithameansof disconnecting the power without disturbing terminated wiring (e.g. knife-switch-type terminal blocks). Visual indication of a blown fuse condition shall be provided.

Allfieldinstrumentcomponentsshallbeofaproven andreliabledesignandshallhaveahighdegree of uniformity and shall, wherever possible, be interchangeable. The design shall facilitate easy maintenance and repair, taking into account the availability of access routes through plant and structures generally.

Field Instruments shall perform sensing, indicating, transmitting and controlling. The devices shall generallyinterfacewiththeSCADA,eitherdirectlyorindirectly.Thematerialsofthose partsofthe field instruments, including piping material, which are exposed to the measured media, shall be compatible with the conditions of the respective media and of the ambient fluid and atmospheric conditions.

All fieldinstrumentsshallbemountedwithinenclosuresthatarecorrosionproof,dustpro ofand waterproof to provide a minimum protection specified in elsewhere in this Specification.

Allfieldinstruments,includingthecomponents,shallbetropicalisedanddesignedfort heambient conditions detailed elsewhere in this Specification. Lighting protection barriers shall be used for protecting transmitters and receiving instruments from the surge voltage due to lighting strike. Lightingprotectionbarriersshallbesuppliedatbothreceivingandsendingendsforalls ignalsfrom outside building and those installed between the buildings.

InstrumentationDesignCriteria

Thedesigncriteriatobeappliedtoinstrumentationsystemsshallbeasfollows:

- Allinstrumentsshallbesuitableforcontinuousoperation;
- Alltransmittinginstrumentsshallhavea4-20mAlinear output;

- Alldigitaloutputsshallbevoltfree;
- Allinstrumentsshallbedesignedfortheambientconditionsoftemperatureandhumidity;
- Allwettedpartsofinstrumentssensorsshallbenon-corrosiveandsuitableforusewith sewage;
- Allinstrumentationsystemsforuseoutofdoorsshallbeprotectedto IP66;
- Allanaloguedisplaysshallbeofthedigitaltypewithnomovingpartsutilising LCD/ LED technology;
- Instrumentation shall utilise solid state electronic technology and avoid the use where practical of any moving parts;
- Minimummaintenancerequirement;
- Instrumentationshallresumeoperationautomaticallyontheapplicationofpowerf ollowinga power failure.
- Allanalyticalinstrumentsshallbesinglechannelandhaveindividual analyzerunits.

Digitalsystemsshallbeprovidedasdetailedin theEmployer’sRequirementsandasnec essaryforthe efficient and safe operation of the treatment plant

TheContractorshallprovidePlanttomeasureanyotherparameterrequiredforthe efficientandsafe operation of the treatment plant.

Instrumentation sensors shall be suitable for the environment in which they are expected to work.
Sensorlocatedinhazardous(flammable)orpotentiallyhazardousatmospheresshall becertifiedfor use in these areas. Sensors should be of self-cleaning type.

Instrumentationconverterunitsshallwherepracticalbelocatedintheassociated MC Ccommon control panel well away from any injurious effects of the process.

FlowMeasurementand Control

The Contractor shall use electromagnetic flow meters(for Sewerage Fluids/Minimum Fluid Conductivity is recommended by the manufacturer for the measurement of Sewage Flow by using Faraday’s law of Electromagnetic Principle) and the flow meter shall be installed in the pipeline withinasuitableaccesschamber.Theaccesschambershallbedesignedtoprovideade quatespacefor

personnelaccesstothechamberandaroundtheflowmeterformaintenance.Theflowmetersystem shall provide flow rate and totalized flow indication.

Thepressureratingoftheflowmeter andflangesshallbeequaltoorgreaterthanthat ofthepipeline within which it is installed. The preferred location for the flow meter converter/transmitter units is within a building. Wherethis is not possible,then the converter shall beinstalled in a suitableabove ground enclosure providing the converter with suitable mechanical and environmental protection.

The flow signal converters/transmitters shall provide 4-20mA output linearly proportional to the rate offlowandshallprovideapulseoutputforflowtotalizing.Theflowmeterelectronicsupervisoryunit shall display the following on a minimum:

- Flow rate;
- Flow total/totalizer;
- Highflowratealarm;
- Lowflowrate alarm.

SignalsfortheitemsaboveshallforminputstothePLCandSCADAandbeutilizedwithin Operator displays. The integrator used for the second item above shall have at least six digits.

Eachflowmetershallbeprovidedwithdownstreamandupstreamisolationvalveincludingthe washout facility.

A.ElectromagneticFlowMeter

Fullboreelectromagneticflowmetersshallbedesigned,manufacturedandcalibratedtoISO standard.The flow meter shall be capable of measuring bi-directional flow.

TechnicalSpecification

(i) ProcessLiquid

a.	Liquid Type	RawSewageWater

(ii) OperatingCondition

a.	Operatingpressure	Asperflangerating(ProcessRequirement)
b.	Operatingtemperature	AsperProcess Requirement.

(iii) FlowSensor

a.	Type	PulsedDC excitation
b.	System	Separatewithcableoutput
c.	End connections	FlangesofCarbonSteel
d.	Electrodematerial	SS316(Stainlesssteel)/Platinum/ Tantalum
e.	Meter tube	AsperProcess Requirement.
f.	Electrodetype	AsperProcess Requirement
g.	Lining material	AsperProcess Requirement.
h.	Protectioncategory	IP68
i.	Measuringaccuracy	Measuringaccuracy + / - 0.5% of measured value inclusive of linearity,repeatability,pressureeffectand hysterics between 0.5 – 5 m/s velocity
j.	Connection/JunctionBox	SS304/Diecastaluminium/ Carbonsteel
k.	Earthing	GroundingRingsinSS304/ Electrode
l.	Fluid conductivity	>20μSiemens/ cm
m.	Marking	Directionofflowwitharrow,size,Sr.No., make

(iv) FlowTransmitter/ Converter

a.	Type	Microprocessorbased,ModularDesign, remote mounting
b.	Displaylanguage	English
c.	Ambienttemperature	-2°Cto +60°C
d.	Display	4digitLCD/LCD,forflowratein m3/hr. 8digitLCD/LCDfortotalizedflowin MLD.
e.	Outputs	Onescalablepulseoutput One status output OneIntegratorOutput
f.	ProtectionCategory	IP67
g.	Enclosure	DieCastAluminiumwithpolyurethane finish with glass window
h.	Programming	opticaltouchkey/ UpdatedRunningversion
i.	PowerSupply	230VAC,50Hz(orAsperSitecondition)
j.	Cable Gland	1/2” NPT (F) - National Pipe Thread(female)(4glandsofdouble compression type)
k.	Mounting	Wallmounted/Panelmounted
l.	Interface	RS485,basedonEIAR422/485standard, or HART
m.	Powerfailuremode	Provision of RAM / EEPROM to store parameterenteredandmeasuredflow data during power failure
n.	Max. Separation	Up to 200 meters between sensor and transmitterswithinprefabricatedcable.
q.	Interchangeability	Fullyinterchangeablewithallsizesoffllow sensors
r.	Safetyclassification	Generalpurposecertification
t.	Backuppower	FromUPS

u.	Passwordprotection	Required
v.	Cable	Required
vi.	Lightningprotection	Required

CalibrationforFlowmeters

The flow meters shall be calibrated for the accuracy of velocity measurement wherein the velocities shall correspond to the flow range of the flow meter covered in the tender. The calibration shall be carriedoutforallflowmeters(100%)undertest,consistingofflowsensorsandflowtransmittercum computation unit.

The calibration method shall be either gravimetric method or volumetric method. The 'test bed' shall be accredited by national /international certifying authority as per ISO 8316 (Calibration by VolumetricMethod)orISO4185(Measurementoffluidflowinclosedconduits–weighingmethod).

The Contractor shall produce accreditation certificates for the test facility and the calibration certificatefortheflowmeterforreviewbyEngineerandshallalsodemonstratecompletecalibration onthetest bedintheflowmeterlaboratoryduringwitnessingoftheFactoryAcceptanceTest(FAT). The flow meter shall be acceptable if the accuracy and repeatability is equal to or better than those specified.

Note:-
InadditionwithFAT,Thesitewitnesstestshallalsobeofferedforinspectionduringsite acceptance test (SAT) for flow meter assessment based on factory calibration reports.

IntermediateSewagePumpingstation(ISPS)Control

The Intermediate sewage pumping station (ISPS) shall be controlled through fully Auto-Mode by Standalone Control System implemented by the PLC Programmer based on Approved Control Philosophy Write-Up. The ISPS PLC shall be linked with downstream STP and Master SCADA ControlCenterviaredundantwirelessGPRScommunicationEquipment.ManagedEthernetSwitches shall be considered. CPU and I/O shall be from the same logic family. No deviation from this requirement shall be allowed.

A separate Control Room is not required for ISPS's i.e. the control equipments

along with
InstrumentationControlPanel(ICP)shallbekeptatthelocationwhichisdust-
proofandtemperature controlled.

In any case Failure of control system, the entire ISPS operation shall also be controlled through Manual-ModefromLocalControlPanelsorLocalPushButtonStationsalongwiththeirEmergency- Stop Push Buttons.

Note:-InanyModeofOperation,allEmergency-StopPushButtonsarealwaysinActiveModeand send their Feedbacks to PLC Control System.

TheminimumISPSprocessesfollowingI/O'sthatshallbecontrolledandmonitoredbythePLC Control System are as below:

Pump,Motor:Start,Stop,Local/off/Remote,Auto/Manual(softsignal),Run,EmergencyStop, Fault

Valve:Auto/Manual,Open,Close,TravellingIndication,Fault

Drives/VFD:Start,Stop,Local/off/Remote,Auto/Manual(softsignal),,Run,Available,Emergency Stop, Fault, speed command & feedback (through Analog), Voltage/current

LevelIndicator:HH,H,L,LL,Analogvalue,Alarm

LevelSwitch:HH,H,L,LL,Alarm

Hand Switch: L, O, R

PressureIndicator/transmitters: Pumpscommondischarge,AnalogValue,Alarm

FlowIndicator/Transmitters: Pumpscommondischarge,Analogvalue,totalizer,Alarm

EmergencyStop:pumps,Drives,motor,etc...

Note:-TheContractor hastoprovideallthenecessaryinterlocks&Protections(asperElectrical& Process parameters) as per the Operational Requirements.

IntegrationofISPS:

TheISPSshallbeintegratedwithdownstreamSTP(s)viaredundantwirelessGPRSco

mmunication equipment. The sequence of data transfer is as follows:

ISPS

1. ISPSshalltransmitdatainbulktothedownstreamSTP.
2. ISPS shall transmit the same data in bulk to Master SCADA control center -Sewerage SCADA server at Shimsha Bhavan Jayanagar.
3. Data polling shall be configured for every half an hour duration. In the event of alarm and events, data shall be immediately transmitted to the downstream STP and Master SCADA control center.

LevelMeasuring System

A. RadarTypeLevelTransmitter(Non-ContactTypeMeasurement)

1.	**General:**	
a)	MeasuringPrinciple:	FrequencyModulatedContinuous Wave
b)	Applications:	Continuous Sewerage Level Measurement for Screens (DifferentialLevelatUp-stream&Downstream)andWet well applications.
2.	**Sensor:**	
a)	Range	SewerageLiquid:0to15mforwetwellapplicationand0to 12m with upstream & downstream probes for screen application.
b)	Temperaturerange	-40°C... +60°C
c)	Max Pressure	3 barabs
d)	Materials	Sensor:PVDFSeal: EPDM
e)	Antenna	Inbuiltwiththesensor
f)	Processconnection	Threadedoruniversalflangedependentonmodel selection
g)	Degreeof protection	IP65orbetter
h)	Beamangle:	8°

i)	Measuringfrequency:	80 GHz
3.	**Transmitter**	
a)	Output	4-20mAHARTcurrent
b)	OperatingVoltage	2-Wire,24vDC
c)	Housing	DieCastAluminium
d)	Electromagnetic compatibility	AsperthestandardsofEN61326,AnnexA(Industrial) and NAMUR Recommendation NE 21 (EMC)
e)	IngressProtection	IP66orbetter
f)	Accuracy	Betterthan+/-5 mm
g)	Area Classification	Non-Hazardous
h)	Display	4lineLCDdisplay.Service:DisplayofEnvelope curve.
i)	Configuration	UsingKeypadon display

B. Conductivitytypelevelswitches

ConductivitytypelevelswitchesshallbeprovidedinISPSWetwellsforcontrolofcoarse screens(2- point)andWet well(4-point).Theweatherprotectionclassforsensorandcontrollershall beIP-65of IS 13947. Each level detector shall be of conductivity type and comprise of PVC insulated rigid stainless steel electrodes.

(a) TechnicalParticularsforElectrodes/ Probes

(i) No. of electrodes :AsperTenderP&ID(Eg:-forCoarsescreens(Inlet),ISPSWet well .. where ever applicable as per Tender P&ID)

(ii) Materialof Electrodes :SS316,RigidwithPVC/PTFEcoating.

(iii) Mounting :Flanged;150LBSANSIB.16.5

(iv) Lengthofelectrodes :Tobefinalizedduringdetailedengineeringasper process requirement.

(v) Spacersbetweenelectrodes: Required

(vi) Stillingpipe :Required(SS316)

(vii) Weatherprotectionclass forlevel probe :IP65ofIS13947

(b) LevelController

(i) Type : FieldMounted

(ii) SwitchContact(foreachsetting) : 2 NO+ 2NC

(iii) Contactrating : 240V AC, 2A

(iv) Sensitivitycontrol :Required

(v) Weatherprotectionclass :IP-65of IS 13947

(vi) Cabinetformountinglevel

Note:-
TheLevelSwitchesshallbereservedasbackupforLevelTransmitters.Hence,thesame is applicable for Level Measuring System

PressureGauges&TransmittersandPressureSwitches

Pressure gauges shall comply with BS EN 837-1 or equivalent Indian standard and have concentric scales.Forspecialarduousdutywherethegaugeissubjecttopressurepulsationsand/orvibration,it shall be provided with a glycerine-filled dial and line snubbers shall be used.

Bourdon-tube type differential-pressure gauges shall be capable of withstanding full line pressure on any side with the other side vented to atmosphere without damage to or effect on the calibration. No plastic material shall be used in their construction. Internal parts shall be of stainless steel,

bronze or approvedCorrosion-resistantmaterial.Wherenecessary,aSchafferdiaphragmtypeofpressuregauge

shall be used to segregate the gauge tube from a corrosive fluid media. In chlorine and sulphur dioxideapplications,thediaphragmshallbeinsilverortantalum.Forotherfluidsanappropriate diaphragm material shall be used.

Theminimumdiameterforroundpressuregaugesshallbe100mmunlessspecifiedotherwiseor where the gauge forms part of a standard item of equipment.

UnlessspecifiedelsewheretheaccuracyforpressuregaugesshallbeÂ±1%ofrange,fordiaphragm gauges 1% of range and for differential gauges 1.5% of range or better.

Where compensation of more than 2% of the instrument span is needed for the difference in level betweentheinstrumentandthetappingpoint,thereadingshallbesuitablyadjustedandtheamountof compensation shall be marked on the dial.

Thezeroandspanofapressuretransmittershallnotchangebymorethan0.1%ofthespan per Celsius degree change in ambient temperature.

Pressure transmitters shall have an accuracy typically better than 0.1% of span, depending on the applicationandshallbeprotectedtoBSEN60529:IP65standardorhigherstandard(or equivalent Indian standard). For transmitters installed in meter chambers liable to flooding or underwater applications,theyshallbetoBSEN60529:IP68standard(orequivalentIndianstandard)andshall operate up to maximum submergence of 20 metres of water.

Pressuretransmittersshallprovideadigitalor4mAto20mAdcoutputproportionaltothepressure range.

Pressuregaugesandtransmittersshallhaveprimaryisolatingvalves,2or3wayvalvemanifoldand vents, in such a way that it has the facility to calibrate the gauges or transmitters without removal.

Strain-gagePressureTransducersandTransmitters

Strain-gauge pressure transducers shall use thin film sensors without bonding. Each instrument housing shall be of all-welded Grade X 4 CrNiMo stainless steel or equivalent and hermetically sealed. Non-interacting, zero and span adjustments shall be provided on each transducer. The measuringdiaphragmshallbeisolatedfromtheprocessfluidbyanon-

corrodiblebarrierdiaphragm.

Themeantimebetweenfailuresforanymodelofstrain-gaugetransducershallbenotlessthan15 years, and the performance of the measurement system shall be as given below or higher performance:

- Accuracy:±0.1%ofcalibratedspan,includinglinearityHysteresisandrepeatability;
- Repeatability:±0.05%atmaximumspan;
- Stability:±0.1%ofupperrangelimitover6−monthPeriod;
- Over-pressure:sustaina400%over-pressurewithoutdamage;
- RFI/EMIeffect:lessthan1%ofspanwith500MHzat5Wdirect contact;
- Power-supplyvariationeffect:0.01%pervoltvariation.
- Loadvariationeffect:±0.0002%perohmofloop-resistancevariation.
- Temperature:−29°Cto+82°Crange;totalthermalerrorof±0.75%ofspanover0°Cto50°C;
- Protection:IP65.

Strain-gauge transducers which do not have terminals for their cable connection, shall have integral sealed-cableassemblies,installedinconduitandterminatedatweatherproofjunctionboxes, protected to IP 65 each mounted nearto itsassociated process transmitter. A digitalor 4mA to 20mA dc output signal proportional to the transducer range shall be provided.

Strain-gaugepressuretransmittersshallbegenerallyasthetransducerexceptthatitshallincorporatea waterproof pressure transmitter producing a digital or 4mA to 20mA output signal.

Provisionfortransducerventingshallbeprovided.

ApprovedVendor/Manufacturer/MakeList- Instrumentation

(i)ListofMakesfor Instruments:

S. NO	DESCRIPTION	VENDOR/MANUFACTURER/ MAKE

S. NO	DESCRIPTION	VENDOR/MANUFACTURER/ MAKE
1	LevelIndicatorTransmitter	M/ sEMERSON M/s ABB, M/sNivelco M/ sRoyceInstruments M/s Global Water M/ sEndress+Haus er M/s Pulsar M/s Kobold M/sYokoga wa M/s Siemens M/sVega
2	Flowmeters/ FlowIndicator/ Transmitter	M/sEMERSON M/sABB M/ sRoyceInstruments M/s Dynameters M/sPulsar M/sYokogawa M/s Endress+Hauser M/sKrohneMarshal

		l M/sSiemens
3	Level Switches	M/sEMERSON M/sABB

S. NO	DESCRIPTION	VENDOR/MANUFACTURER/ MAKE
		M/sNivelco M/sRoyceInstruments M/sEndress+Hauser,M/ sKobold M/s Pune Techtrol
4	PressureGauges/ Pressure Switches	M/ SWarry M/SABB, M/s Wika M/sKobol d M/sGenInstCo M/s Switzer M/sDandfoss
5	PressureIndicatorTransmitter	M/ sEMERSON M/s ABB, M/s Kobold M/s Switzer M/sRosemo unt M/ sEndress+Haus er M/s Siemens M/sVega

(iii) ListofMakesforUPS&Batteries:

(iv) ListofMakesforUPS

S. NO	MANUFACTURER/MAKE
1	M/sAPC
2	M/s DB&ELECTRONICS
3	M/sHI-REL
4	M/sNUMERICPOWERSYSTEMS

(b)ListofMakesforBatteries

S. NO	MANUFACTURER/MAKE
1	M/sAMARRAJA
2	M/sHBL NIFE
3	M/sAMCO
4	M/sEXIDE

iii) ListofMakesfor Cables

S. NO	MANUFACTURER/MAKE
1	M/sUniversal Cables
2	M/sPolycab
3	M/sHavells
4	M/sCCI
5	M/sFinolex
6	M/sNICCO
7	M/sDeltonCablesLimited
8	M/sThermocables

(iv)ListofMakesforEnclosures/ Panels

S. NO	MANUFACTURER/ MAKE
1	M/sRittal
2	M/sECIL

In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer'sservice,likeitemsofequipmentprovidedhereundershallbetheendproductsofone (1)manufacturer.

Thenamingofamanufacturerinthisspecificationisnotintendedtoeliminatecompetitionorprohibit qualified manufacturers from offering equipment.Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

Intheeventthatthecontractorwishestoproposealternatemakesfortheequipmentmentionedabove, he shall submit the following:

4. Demonstratethatthemakesaresuperior/Equivalenttotheapprovedmakes.
5. Manufacturer involved in manufacture of specified equipment for at least 10 years before biddate.
6. At least 3 successfulinstallationscommissioned inlast5 years beforebiddate andsatisfactorily operating for at least one year before bid date
7. Manufacturertoprovidefullcontactinformationforeachreferenceaspartoftechnicalbid.

13.9ControlPhilosophy

GeneralControl Philosophy

This section describes the general control philosophy that the Contractor shall follow for ISPS pumping mains included in this contract. These requirements are specified for tender purposes only and the information provided is not intended for construction. The bidders/contractors shall submit moredetailedandspecificversionsofthecontrolphilosophyandthefunctionaldesign specifications in both the bidding and design stages.

ThecontractorshallnotethattheISPSshallbedesignedtooperateinfullyautomatic(automode)of operation at all given times. In the event of failure of the same, facility shall be provided to operate the Pumping station in manual mode till such time the auto mode is again available. Design shall incorporate level, flow and pressure interlocks to ensure plant is operated in a safe condition at all times and to ensure maximum uptime. Contractor shall note the importance of this requirement.

TheISPSincludedinthiscontractshallcompriseitems,components,andunitprocesses describedin Process Requirements and elsewhere in these bid documents, and shall include but not be limited to all supporting and ancillary equipment, accessories, instrumentation, controls, automation, and any and all other components required for proper, easy, andautomatedoperationand functioningand for accomplishing the specified performance objectives.

IncomingrawsewageshallbescreenedbymechanicalcoarsescreenslocatedupstreamofISPSand shall be pumped to the destination STP by raw sewage pumps designated as ISPS Pumps.

AllsignalsreceivedorgeneratedbythesystemPLC,includingalarms,shallalsobetran

smittedtothe downstreamSTP SCADA/HMIfor monitoring, and operator shall have option to provide all required operator input (including but not limited to set points, start/stop control, open/close control, speed

control,etc.)eitheratthesystemPLCoratthedownstreamSTPSCADA/ HMI.Allsignalsshallbe transmitted using redundant GPRS communication.

The Contractor shall develop a logical, meaningful, modular, and expandable tag numbering system for all control elements, including but not limited to equipment, instruments, actuators, and control loops. The numbering system shall be such that components of the tag number provide immediate indication of the type of element (e.g. pump, valve, flow meter, etc.), its location and/or unit process, andthenumberofsimilarmodularunitsproposed.Thesystemshallallowforeasymodifications such as future addition of units for expansion. The Contractor shall submit the tag numbering system for Engineer's review and approval prior to implementation.

The Contractor shall submit for Engineer's review and approval I/O lists in each hierarchy level such asfieldlevel,localcontrolpanel,localelectrical/MCCroomlevel,ISPSSCADA/ HMIlevel,andthe Sewage Master Control Centre. The I/O list shall be categorized into discrete input/output signals, analog input/output signals, signals through field bus, and signals through LAN communication at each level. The list shall also contain process/equipment status and alarm/fault signals, commands to process,and logitems for historical records. All alarms shall be visuallyand prominentlyindicated at the local panel, the ISPS SCADA / HMI, as well as the Sewage Master Control Centre. Criticalalarms shall also be annunciated on same SCADA / HMI for immediate attention to the Operator at ISPS site. The Contractor shall submit full alarm schedule details including designation of critical alarms and annunciation locations for Engineer's review and approval prior to implementation.

IntermediateSewagePumpStation (ISPS)

ThissectionappliestoISPSincludedinthiscontract,pleaserefersP&IDNo – TCE.7731A-BWSSB- WW-05-6015 for further details.

ISPSCoarseScreens

Gravitysewageflowshallentertheinletcommonchannelofcoarsescreens.Thehighlevelswitchin this channel shall initiate a coarse screen cleaning cycle, and both the high and high-high level switches shall generate an alarm.

Gateswithmanualhandwheeloperatorsshallbeinstalledbothupstreamanddownstreamofeach coarse screen so that each screen channel can be isolated for maintenance.

The coarse screens shall be operable manually from a local control panel located adjacent to the equipment or remotely from the ISPS SCADA / HMI. Remote operation shall be operator selectable asmanualorauto.Inautomode, operationofthecoarsescreenrakemechanismshallbecontrolledby level differential with a timer override. Level elements shall be installed both upstream and downstreamofthecoarsescreens.Whentheupstreamminusdownstreamlevel differential reachesan operator specified maximum, a screen cleaning cycle shall be initiated. Alternatively, the operatormay also specify a maximum interval between cleaning cycles. If this interval elapses without cleaning, a cleaning cycle shall be initiated regardless of level differential. The upstream and downstream levels shall be continuously monitored by Radar type level sensors/transmitters.

Note- The Automatic Jam removal feature shall be applicable for each screen system and the same is to be implemented by using control logic built along with the screen control system whichwillgoingtobesuppliedbytheScreensupplier.TheScreenControlSystemdataistobe integrated to ISPS SCADA / HMI System by using hard wired communication system.

ISPSCoarseScreeningsConveyer

ThescreeningconveyershalloperateinAutomodeinlinkagewiththecoarsescreens.Thescreening conveyer can be operated manually by the operator at a local control panel located adjacent to the equipment for trouble shooting or maintenance, or at the ISPS SCADA / HMI.

Alarms/faultsandstatusshallbemonitored/ loggedandcontrolcommandsshallbegeneratedin accordance with the Engineer-approved I/O list.

ISPSPumps

The raw sewage enters the wet well after passing through the coarse screens. There are two compartmentsofthewetwellwithanisolationgatebetweenthem.Thetwocompartments ofthewet well in the ISPS will be used as a single compartment with the isolation gate open under normal working condition to provide sufficient storage between the two to reduce frequency of pump start/stop.Theisolationgatecanbeclosedmanuallyformaintenancepurposes.Sincethewetwellis in two compartments, inlet isolation gates will prevent flow into either compartment during maintenance works.

Thetotalnumberofpumpsshallbedistributedequallybetweenthetwowetwellcompartments. 1outof 4 pumps in each compartment shall be VFD driven. Under normal operation, one set of the pumps shall be designated as working and the other as standby. Radar level elements as well as low, low- low, high, and high-high level switches shall be installed in each compartment of the wet well.

The pumps shall be operable manually at a local control panel located adjacent to the equipment or remotelyattheISPSSCADA/HMI.Remoteoperationshallbeoperatorselectableasautoormanual. In auto mode, sequencing shall be controlled based on wet well level. The operator shall be able to specify start and stop levels for each working pump. The working pump shall start first (at pump 1 Level). As wet welllevelrises, pump 1 shallbe startedat Pump1 levelreaches.Asthelevel continues to rise from start level for pump 1 to start level of pump 2, and then pump 2 shall be started. If level continues torise fromstart level of pump 2 to start level of pump 3, then pump 3 shall be started then further Level continues to rise from start Level of pump 3 to start Level of pump 4 then pump 4 shall be started . The above sequencing shall be reversed for decreasing wet well level.

Note:-
TheStepControlLogichastobeimplementedwithVFDspeedsynchronizationforeach wet well.

An Electromagnetic type flow meter and Pressure Transmitter installed on the raw sewage pump dischargeheadershallmeasureandtransmittherawsewageflow&Pressuretothedownstream STP SCADA/HMI.

AlltheISPSpumpsshallhavethefollowingPLCcommunicationsignalsasminimuminbelow section.

MinimumI/OListRequirement tobeprovidedas follows:

SL.NO.	**DESCRIPTION**	**TypeofI/O**	**NoofI/O**
1.	**PLCINTERFACEFORUNIDIRECTIONALLTDRIVE(SignalExchange envisagedbetweenPLCandPCC/MCC)**		
a.	StartCommand	DO	1
b.	Stop Command	DO	1
c.	RunFeedback	DI	1
d.	Local/Remotefeedback	DI	1
	Auto,Off,Manual(Softsignal)feedback	Soft	3
	Availablefeedback	DI	1

e.	Trip(Overloadrelayoperated/ controlsupply fail/	DI	1

SL.NO.	DESCRIPTION	TypeofI/O	NoofI/O
f.	EmergencyStopfeedback	DI	1
g.	VFDSpeed Command	AO	1
h.	VFDSpeed feedback	AI	1
2.	**PLCINTERFACEFORBIDIRECTIONALLTDRIVE-ForIntegralstarters (Signal Exchange has been envisaged between Actuator and PLC.)**		
a.	OpenCommand	DO	1
b.	CloseCommand	DO	1
c.	Trip	DI	1
d.	Openlimitswitchfeedback	DI	1
e.	Closelimitswitchfeedback	DI	1
	Local/Remotefeedback	DI	1
f.	PositionTransmitter(Forcontrol Drive)	AI	1
g.	PositionCommand(Forcontrol Drive)	AO	1

Note:- In Auto-mode operation from SCADA / HMI, the Duty Rotation Logic shall be implemented withcasetocasebasisforeachWetwellPumpbasedonallpre-definedPermissivesalongwithLevel Interlocks including Duty period of each pump and also the same shall be incorporated in Control Philosophy document for prior approval of Employer's representative. After getting approval of the Control Philosophy document Functional schematics shall be submitted by the contractor prior to Logics development in the PLC.

ABBREVIATIONSUSED

AMF AutomaticMainsFailure

API ApplicationProgramInterface

COM/DCOM

ComputerObjectModel/DistributedComputerObjectModel BWSSB

Bangalore Water Supply and Sewage Board

CPU CentralProcessor Unit

SCADA SupervisoryControlandDataAcquisitionSystem

DDE	DynamicDataExchange
DLP	DataLossPrevention
EMCS	ElectromagneticCompatibilitySociety
FBD	FunctionalBlockDiagram
FOC	FibreOpticCable
GPRS	GeneralPacketRadioService
GRP	GlassReinforcedPlastic
GSM	GlobalSystemforMobile
HMI	HumanMachineInterface
IEC	InternationalElectrotechnicalCommission
I/O	Input/Output
ISO	InternationalStandardsOrganization
ISA	InstrumentSymbolsandIdentification
IT	InformationTechnology
LAN	LocalAreaNetwork
MIS	ManagementInformationSystem
MLD	MillionLitresperDay-
MUX	Multiplexer
OPC	OLEforProcessControl
OSI	OpenSystems Interconnect
PLC	ProgrammableLogicController
ISPS	IntermediateSewagePumpStation
RTU	RemoteTerminal Unit
SCADA	SupervisoryControlandDataAcquisition
STP	SewageTreatment Plant
TCP/IP	TransmissionControlProtocol/ InternetProtocol

TE	TreatedEffluent
VBA	VisualBasicfor Applications
VFD/VSD	VariableFrequencyDrive/VariableSpeedDrive
Windows™	MicrosoftWindows
XML	ExtensibleMark-upLanguage

SystemCompleteness

ThissectionofspecificationsdefinestheparticularrequirementsofInstrumentation andControl systemto be installedat ISPS. For selection of fieldinstruments andcontrol systemor anything related to instrumentation, the Contractor shall follow the specifications contained herein.

BeingaTurnKeycontract,irrespectiveofthedetailedspecificationsoftherespectiveitemsdetailed in the various chapters of the tender specification, the Contractor shall be required to provide all the equipment, accessories, cabling, earthing, providing necessary transducers/sensors, system hardware/software, programming logic, interlocks, cabinets, panels etc. to achieve the functional requirements described in the Bid Document.. The **System completeness** will be the Bidder's responsibility.

Note:

InFATallthefieldinstruments&Automationsystemsshallbetested100%undercategory-'A'.The description about category -'A' already mentioned in clause 14.1.2 of part-14.

PARTICULARREQUIREMENTSFOR PLC &INDUSTRIALHMISYSTEM

General

This part covers the general & Particular requirements for the design, supply, installation, InspectionandtestingofProgrammableLogicControllers(PLC)andSCADA/HMISystem and associated plant and materials.

RelatedSections

A. Part7- GeneralInstrumentation&ControlRequirements

ApplicableStandards

Allequipmentshallcomplywithallapplicablenationalandlocallawsregulation sand standards, in addition to those listed below:

A.	ISO9000and 09004	-	QualitySystems
B.	IEEE587	-	PowerSupplySurge Protection
C.	IEC 61131-3	-	ProgrammingLanguagesforProgrammable Controllers.
D.	IEC61158-2	-	CommunicationProtocols
E.	ISO9075(BS6964)	-	StructuredQueryLanguage(SQL)
F.	BS5515	-	DocumentationofComputerBasedSystems
G.	BS 7165	-	RecommendationforAchievementofQualityin Software
H.	BSEN 50081	-	ElectromagneticCompatibility
I.	ISO 3511	-	Process measurement control functions instrumentationsymbolicrepres entation.
J.	ISO-OSI	-	7LayerCommunicationModel
K.	IEEE472-1974	-	Surge protection.
L.	IEC61850	-	PLCsub-stationautomation protocol.
M.	IEC8705101	-	Modbusprotocolconversion

StatementofCompliance

The Contractor shall provide a list of the reference standards used and shall provide a compliance/non-compliance statement during the Bid submission, and FDS submission. Failuretodosowillbetreatedasanon-

responsivebid.Contractorshouldtakenoteonthe importance of this obligation.

QualityAssurance

A. TheManufacturersshallbeoperatingunderanaccreditedISO9001orabov eQuality System.

B. Upgrades and improvements to the manufacturers standard system that are released before the expiration of the warranty period shall be supplied, installed and commissioned at no additional cost.

Theseshall includeallhardwareand softwarenecessaryto implement theupgrade.

Submittals

A. **FunctionalDesignSpecification(FDS):**

The Functional Design Specification (FDS) shall be submitted to the Engineer within 3 months on the award of the contract and approved before manufacture and purchasing commences.FDSdocumentforISPSshallbesubmittedwithinthetimeperiodi ndicated above. The system vendor and/or Contractor shall include the following material as a minimum:

a. ProjectOverview,designconcept,criteriaandsystemarchitecture

b. Descriptionofthedesignanddesign criteria.

c. Detailsofassociatedequipment.

d. Datasheetsoftheproposed equipment.

e. ElectricalDesignSpecifications

f. QualityPlan.

g. Outlineofacceptancetestprocedures(FAT&SAT).

h. Implementationprogramformanufacture,inst allationand commissioning.

i. Manufacturersliteratureforeachitemofequipmentsupplied/proposed.

J.DetailedPlantscreens(completeMIMICscreen,IndividualScr eenWindows for Industrial HMI).

k. softwarearchitecture,etc..

Note:Contractortonotethatnopartapprovalof FDSwillbeaccorded.FDS shall be submitted in full with all details as detailed above.

B. **DrawingsandDocumentation:**

AlldrawingsoftelemetryandinstrumentationcontrolandAutomation(ICA)equipmentshall be on A3 or A4 size sheets, with title blocks approved by the Engineer.

SignatureoftheContractorsauthorizedrepresentativetoindicatethedrawingshavebeen checked prior to submission.

ThetextofalldrawingsanddocumentationprovidedbytheContractorshallbeintheEnglish Language.

C. **Contractor'sDrawings:**

TheContractorshallsubmit3(three)reproduciblecopiesplustwophotocopiesofgeneraland detailed dimensioned arrangement drawings, schematics and wiring diagrams of all major items of Plant, for the Engineer's approval Manufacture of an item of Plant shall not commence until the associated drawings have been approved in writing by the Engineer.

AllmodificationsorrevisionstodrawingsshallbeclearlyindicatedandtherevisionreferenceChanged.

DrawingsaffectingworkbyotherdisciplinesshallbeprovidedtotheEngineer, within6 weeks from the date of enterprise.

Drawingsforelectricalequipmentshallinclude:

(i) Manufacturer's generalarrangement drawings for allitems showingclearlythe positionofallcableglandsandmaincomponentsincluding,whereappropriate, foundationplans,showingthepositionofallholesrequiredforfixingboltsand cables etc.

(ii) Manufacturers' schematic diagrams and connection diagrams for all items showingallinternalwiringandterminalconnections,suitablyreferencedConnectiondiagrams shall include existing and proposed outgoing cable connections.

(iii) Generallayoutofplantshowingcablerouting.

(iv) Blockdiagramshowingallplant,cablerunsandcablereferencenumbers.

(v) Cableschedulesgivingfulldetailsofuse,destinations,sizeand

numberof conductors, grade, class and length.

(vi) Layoutofgroundingfacilities.

(vii) Proposed arrangements for cables laid below ground showing identification references,voltage,depthoflaying,routeandlength,crossingswithotherservices, location of any joints and position of ducts, with cross sectional arrangements.

TheContractorshallmodifyexistingdrawingstoshowthemodifications.Ifsuitableexisting drawings are not available the Contractor shall provide drawings showingthe modifications.

RecordDrawings:

AspartoftheWorksandbeforeTakingOver,theContractorshallprovideandforwardtothe Engineer, a complete set of drawings comprising two original size permanent transparency and six paper prints, of all final drawings of the Works as installed, schematic wiring diagrams,panelwiringandconnectiondiagrams,cableroutediagramsandschedulesandany other special drawings which have been prepared during the course of the Contract. The Contractor will also provide drawings on computer diskin AUTO CAD (Latest Version), for the modification and printing of drawings. Also all drawings have to be converted to PDF files and stored in the Engineers workstation.

D. TrainingPlan and Manuals:

As part of the Works and before beginning training, the Contractor shall submit to the Engineer, 6 copies of complete operating and maintenance instructions for the system, referringspecificallytothePlant.Thedocumentswillalsobepresentedoncomputerdiskin Microsoft Office 2003/2007 Word or latest version available for Windows software format.

Eachcopyoftheinstructionsshallbecontainedinasubstantialbinder.

Thesemanualsshallincludebutnotbelimitedtothefollowinginformation:

a. DetaileddescriptionsofthePlantoperationandcontrolscheme.

b. Manufacturer’soriginaloperationandmaintenanceprocedures.

c. CompletepartslistforallitemsofthePlant.

d. Recommendedsparepartslist.

e.

Detailedmaintenanceinstructionsforallitemsasnecessaryt omaintain the items in good working order, including all step-by-step procedures for troubleshootingandfaultcorrection.

f. Configurationofdatabase,reports,logsandscreendisplays.

g. Datacommunicationinterfacestandardsandprotocols.

h. FBDandcontrolloopflow diagrams.

i. Programmeuserinstructionforall software

jThe system shall provide on line, complete user documentation, including examples of how to operate the various modules within the system. The documentation must be in electronic format, HTML based with the ability to search for topics by keyword or search for specific text.

SiteConditions

A. Temperature and Humidity Range.The equipment shall be installed in an environment havinga temperature range of 0 °C to 55 °C and a maximum relative humidity of 100 % (non condensing). The Contractor shall use, where required, fans, heaters, and air conditioningunitstomaintainacorrectworkingtemperatureforhisequipment.AllPartsof theequipment shallbeconstructedofmaterials ortreated toprevent theformation of mould, fungusoranycorrosionover the temperatureandrelative humidityrangesspecified.

B. EMI/RFI Noise Immunity.The equipment to be provided shall be adequately protectedagainstinterferencefromtheuseofradiotransmitters,atanypoint externaltothe equipment housings and no malfunction of the equipment shall result from this cause. Responsibility for the correct and reliable operation of the equipment shall rest with the Contractor,whomustensurethattheequipmentisadequatelyprotectedagainstttheingressof radiated, mains-borne signal-borne interference.

C. Generated Interference.The Contractor shall ensure that the computer, instrumentationandcommunicationsequipmentconformstoBSEN50081-1orequivalent IndianStandardfornoise emissions.

D. Coordination.TheContractorshallcheckwithothertradestoensurethateq uipment and material can be installed in space provided.Provide other trades with information necessaryforthemtoexecutetheirwork.DetailsonDrawings,whicharespecifi cregarding dimensions and locations, are for information purposes.Coordinate with other trades to ensure work can be installed as

indicated.

E. Sequencing.The Contractor shall make applications to the local telecommunications Service Provider for provision of communications and coordinate with the sub-contractor responsible for installation of power supply services under this contract.Applications shall be madeintimetoensureservicesareavailableforinstallationandcommissionin gofthetelemetry equipment.

Commissioning

A. The Contractor, the Engineer and any appropriate personnel of the Employershall be present when the equipment or installation is tested & commissioned.

B. Commissioning shall include operating the equipment in a variety of modes and sequences to prove its satisfactory operation, prior to commencing the formal site inspection and testing.

AUTOMATION& HMI SYSTEMCOMPONENTS

Programmable Logic Controllers ISPS PLC

ProgrammableLogicControllers(PLC)shallbeprovidedinastandaloneconfigurationwithSCADA / HMItoperformcombinationalandsequentiallogicfunctions,statusmonitoringandreporting functions with counter and timer facilities.

PLCshallcompriseofnecessaryprocessors,Simplexinput/output(I/O)modulesofthesameseriesof the CPU and communication interface.

PLCshallhavethefollowingattributesasastandalonePLC.

- carryoutsequentiallogicimplementationforoperationsof plant;
- carryoutcomputationandinterfacingfordataacquisition,datastorageandretrieval;
- itshallacceptdownloadedprogramfroma programmer;
- itshallhavedifferentfunctionalmodulestoperformthedesiredfunctions;
- itshallscantheinputsintimecyclesandupdatethestatusofitsoutputs.

The PLC system shall be expandable, OPC Compatible (OPC should be a built in feature of the software and hardware. No external software patch or hardware module is allowed) and shall be modularinconstruction,soastobecapableoffutureexpansionwithouthardware modifications.

PLCsshallbemicroprocessor based.PLCsshallusestandardknownprotocolsandstructuresfor communication outside the system.

Protocolconvertershallbeprovidedforthirdpartyfieldinstrumentsdataintegrationt oPLCSystem, in this case, that protocol converter including any software packages shall be coming from same Manufacturer PLC family. Any deviation on the same is not acceptable.

Incaseofsystemfailureorpowersupplyfailuretheoutputsshallattainapredetermined failsafe condition (this shall normally be ‘off’).

ThePLCusedshallhaveaprovenrecordinthetypeofapplicationconcernedandinthepr evailing environmental conditions. Refer approved vendor list.

PLCSystem(Panel)shouldbehousedinadustfreeenvironment.

PLCCoding

TheContractorshallsupply,install,programandcommissionthePLCusingthePLCma nufacturers recommended windows based PLC coding and documentation software.The PLC code shall be structured in the manner of the best industry standard and have comprehensive subroutine and rung annotation. **Functional Block Diagrams shall be used for coding of PLC.**.

SCADA/HMI

General

TheSCADA/ HMIshall besuitablefordaytodayoperationbynon-computer literatepersonnel in the monitoring and operation of the pumping works.

IndustrialHumanMachineInterfaces(HMI)

The SCADA/ HMI shall be installed on Operator Work Station including Engineering Work station as separate for the purpose of Logic & Graphics updation.
TheHMIsystemshallprovideefficientandsafeoperationoftheprocessplantbydetecti ngalarmand error conditions, alerting the operator to these conditions both visually and audibly, monitoring all important system parameters and providing facilities for plant optimization. The system will allow operators, technicians and engineers to issue commands to change system parameters, start and stop equipment, provide configuration tools and operate diagnostic facilities.

TheSystemshallperformallthenecessaryfunctionsfortheoptimummonitoring,contr oland operation of the entire system.

TheHMIshallbeconstructedtoahighstandardtoprovideahighprofilefeatureandfoca lpointfor visitors to the ISPS.

ApprovedManufacturersListforAutomation

Thenamingofamanufacturerinthisspecificationisnotintendedtoeliminatecompetitionorprohibit qualified manufacturers from offering equipment.Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

SL.NO.	DESCRIPTION	MANUFACTURES/MAKES
1	EngineeringWorkstation	IBM,Dell,Compaqetc.
2	ProgrammableLogic Controllers	SchneiderElectric(ModiconSeries),SiemensPLC(S7-300 series),AllanBradley(ControlLogixseries),ABB(AC800 M Series),Mitsubishi(Q 25 Series),GE(7Xi Series),Omron PLC(CS1 DSeries), Yokogawa (Fat Tools-10)
3	IndustrialSCADA/ HMI and Programming Software's	Intellution IFix, Wonderware, WIN CC V 6.2, RS View, VijeoCitect,Iconics,CX-SupervisorV3andanyotherRun time software's as per requirement etc..,
4	GSM/ GPRSEquipment	Motorola,GE,Seimens,GSVMicrotek,DataRadio,Sheetal Wire-less Systems

In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer'sservice,likeitemsofequipmentprovidedhereundershallbetheendproductsofone
(1) manufacturer.

Intheeventthatthecontractorwishestoproposealternatemakesfortheequipmentmentionedabove, he shall submit the following:

(i) Submitaletterfromthemanufactureoftheeachequipment mentionedabove,thatthemakes mentioned in this document are un-available/not suitable.

(ii) Provideevidencefromthemanufactureoftheproposedequipmentanddemonstratethatthe makes are superior/Equivalent to the approved makes.

(iii) Atleast3successfulinstallationscommissionedinlast5yearsbeforebiddate andsatisfactorily operating for at least one year before bid date.

Note:ThecontrollerandtheIO’shastobefromthesamefamilyandsame series.

UninterruptiblePowerSupply (UPS)

Thepowerforcontrolsystemequipmentsandonlinefieldinstruments shallbederivedfromseparate UPS.

The UPS provided shall be sized to provide sufficient power to maintain system functioning for a period of minimum **60 minutes,** in case of power failure. The capacity of the UPS depends up on actual Load requirement of Instruments and control system equipments in this case; the contractor shallfurnishthedetailedLoadCalculationforallICAequipmentstoEngineerforfinalisationofthe sizing of the UPS. However the minimum size of the UPS shall be not less than 5 KVA.

TheabovefeatureshouldbedemonstratedduringFactoryAcceptanceTest(FAT)&SiteAcceptance Test (SAT).

ParticularSpecifications

ScopeofSpecification

ThepurposeofthispartoftheSpecificationistodefinethebasicrequirementsformicroprocessor- based, programmable logic controllers (PLC) integrated into control system and Industrial Human Machinery Interface (HMI) intended for intermediate sewage pumping station (ISPS).

ProgrammableLogicControllers

(a) DesignandConstructionRequirements

ISPSPLCshallbeprovidedasaStandaloneconfigurationtoperformcombinationalandsequential logic functions, status monitoring and reporting functions with counter and timer facilities.

PLC shall comprise of necessary processors, simplex input/output (I/O) modules, communication interfacemodulesandHuman-machineinterface(HMI)requiredforperformingthedesiredfunctions.

The PLC shall have memory protected built in historical archiving/data logging of system alarms & eventsandprocessvariables.Dataloggershallbeabletologdatabasedontimeoraneve nt.PLCshall haveenoughmemoryallocatedtoallow200,000timeanddatastampeddiscreteand/ oranalogvalues to be archived. The historical archive shall allow the oldest data to roll off the system as memory is used keeping the 200,000 most current data points available. Process point time stamping frequency shall be selectable within the configuration software. It shall be possible for the archived data to be exported in CSV format allowing use with standard spreadsheet and data software applications.

PLCshallhavethefollowingattributesasaStandaloneconfiguration.

- Carryoutsequentiallogicimplementationforoperationsof plant;
- Carryoutcomputationandinterfacingfordataacquisition,datastorageandretrieval;
- Itshallacceptdownloadedprogramfroma programmer;
- Itshallhavedifferentfunctionalmodulestoperformthedesiredfunctions;
- Itshallscantheinputsintimecyclesandupdatethestatusofitsoutputs.

(b) Standalone processor

The Standalone Processor system along with Rack back-plane slots that can be supported Programmable Logic Controller (PLC). The Standalone CPU, Power supply, CommunicationModule, IO & Processor rack (Standard DC), Back up Interface/Expansion Module, Rack (Backplane) 5 slots for IO and Processor and Potential free contacts, RS-485 ports are available with communicationmoduleofthecontroller.HMIconnectivitywiththeCPUwillbeonEthe rnetnetwork (10/100 Mbps with open Modbus TCP/IP protocol).

IndustrialtypeManagedEthernetSwitchesshallbe

provided. PLCCPUandI/Omodulesshall

beofthesamelogicfamily.

Failuretodoadheretotheabovewillbetreatedasanon-responsivebidandleadtotechnical disqualification. Contractor should take note on the importance of this obligation.

(i)

ThePLCsystemshallbeexpandable(OPCCompatible)andshallbemodularin construction, so as to capable of future expansion without hardware modifications.

(ii) The system hardware, application software and database shall be sized to accommodateatotalof50%increaseinsignalcapacityandupto100%increaseina nindividual zone.

(iii) Sufficientpluginmodulesshallbeprovidedandwiredtoterminalsreadytoaccep t future signals of up to 10% for each IO card

(iv) EachIOcardshallbeabletoacceptatleasttwomoreI/Ocardswithoutrequiring replacementof,oradditionsto,theoriginalequipment.

(v) TheISPSSCADADataistobeintegratedwithK&CValleySTPbyusingwireless communicationsystem.

(vi) Thesystemshallbemodularandcapableofintegratingintoanetworkwidemaster SCADAsystemproposedat2ndFloor,ShimshaBhavan,Jayanagar,Bangalore.Adeq uatereferences shallbeprovidedtodemonstratesimilarinstallationsbythemanufacturerbysuing wireless communicationsystem.

(vii) PLCsshallbemicroprocessorbased.PLCsshallusestandardknownpr otocolsand structures for communication outside the system.

(viii) Incaseofsystemfailureorpowersupplyfailuretheoutputssha llattaina predetermined fail safe condition (this shall normally be ‘off ’).

(ix) ThePLCusedshallhaveaprovenrecordinthetypeofapplicationconcerne dandinthe prevailing environmental conditions.

(x) ThePLCshallhaveafieldproventrackrecordandshall befullycompatiblewiththeproposed master SCADA systemlocated at 2ndFloor,ShimshaBhavan,Jayanagar,Bangalore.

(xi) Application logic programs shall be fully compliant with all five logic development methods detailedinIEC61131-3.ThePLCshallbepoweredbytwoindependentsourcesprovidedbythe UPS system and all internal operating supplies shall be derived from the UPS.

(xii) Thepowersupplies,I/

O,CPUandcommunicationmodulesandbatterybackupratesshallbe monitored by the PLC and shall be available by report.

(xiii) During the times of the battery discharge, the PLC shall initiate an orderly self shutdown and automaticallyrestartonthemainpowerrestorationwithouttheneedforreloading orinitiationof any kind.

ThePLCshallcomplywiththespecificationspecifiedelsewhereinthis specification.

Each PLC shall have built in web server capability allowing system information to be stored in a format that allows for easy access and viewing with standard Windows™ based browser. Each unit shallbefurnishedwithbuiltinO&Mdataassociatedwithitsspecificsiteincluding;asa minimum, basic system information, panel layouts, wiring diagrams, material lists w/part numbers, and operational summary. This information shall be accessible locally or remotely

(c) CentralProcessingUnits

Thecentralprocessingunits(CPU)shallbeahighperformanceprocessorwithmodular configuration suitable for real time process applications

Thefollowingadditionalfeaturesshallbeprovided.

HMIconnectivitywiththeCPUwillbeonEthernetnetwork(10/100MbpswithopenM odbus TCP/IP protocol).

IndustrialgrademanagedEthernetswitchesshallbeprovidedforconfigurationofpan elmounted HMI, Engineering Workstation (EW) and all other communication modules with CPU.

CommunicationbetweenCPUandperipheralsshallbebyanI/ Obus.Theindividualdevice, interfaces shall be capable of being plugged into the I/O bus.

OnresumptionofpowerfollowingapowerfailurethePLCshallautomaticallyrestartits controlling function.

CPUshallhavearealtimeclockcapabilitytoacceptatimesynchronizationpulseandadj ustits internal clock with the pulse.

CPUshall haveextensiveselfdiagnosticfacilitiesandwatchdogtimerstoidentifyfaultsatcard levels

(d) MemoryUnit

Memory unit shall comprise of highly reliable memory chips which are industry standard, proven design with fast random access and suitable for operation in process environments.

Mainmemoryshallbemodularandfacilityshallbeprovidedfortheupgradingan dexpansion of memory to meet future demands.

Notlessthan50%spareprogrammemoryanddatamemoryspaceshallbeprovided.System initialization and application software shall be stored in EEPROM or EPROM.Operating data shall be stored in a RAM fitted with an internal battery backup.The battery backup provided shall support the memory on loss of power for at least one month.The battery life shall be at least 2 years.

(e) I/O Modules

Standardrackmounted plugin I/O modules shall be provided. I/O Modules should be of the same series as the PLC CPU. Deviation from this would be treated as a non responsive bid. Contractor should take note on the importance of this obligation. Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with prefabricatedcablesandplugincardtypeconnectors.I/OModulesshouldbehotswappable.

20%extramodulesofinstalledcapacityforeachtypeofmoduleshallbeprovidedasspare. Provision shall be made for future expansion of additional 20% extra I/O modules of the installed capacity.

I/Omodulesshallbeasfollows:

- Inputsshallbeopto-isolated;
- Filtersshallbeprovidedfornoiserejection;
- OutputstatusshallbeindicatedbyanLED;
- All outputs shall be fuse protected and have fuse failure indication the fuses may be mounted externally from the output module;
- Allthemodulesshallbeofaddressabletype.
- Ethernet I/O modules shall be connected to the PLC by on board Ethernet 10/100 BaseT connection port. Ethernet I/O modules shall support multiple communications including TCP/IP and Modbus ASCII and allowing connection to any device supporting these protocols over standard Ethernet backplane.

(f) AnalogueInputModules

Theyshallconsistofaninputisolationunit,signalconditioningunitandananalogueto digital converter (ADC).In addition, the following features shall be provided.

- Crosstalkattenuation
- ProvisionformonitoringoftheADCforoverflowdetection

- Gainamplifierwithhighcommonmoderejection ratio
- Accuracyforanaloguesignalsshallbe0.5%

(g) DigitalInputModules

Thefollowingdesignfeaturesshallbeprovided.

- Contactbounce protection;
- Choiceoftypeof contacts.

(h) DigitalOutputModules

Thedigitaloutputmoduleshallprovidecontactclosureoutputbydrivingrelays. Thefeatures to be provided are as follows:

- Contactbounceprotectionshallbeprovided
- Relayoutputshallbeprovidedtooperatepumpmotorsandmotorisedvalve actuators
- Failsafepositionincaseofoutputmodulefailureandfaultindication

PLC's provided underthisspecification shall becapable of performingthe necessarylogic tocontrol thesystemaspreviouslydefined.Thesecapabilitiesshallinclude,butnotbelimitedtot hefollowing:

- 1. Discreteinput/output
- 2. Analoginput
- 3. Analogoutput
- 4. Timers
- 5. PumpController
- 6. PumpAlternation
- 7. MathematicalFunctionBlocks
- 8. StageBlocks
- 9. Trending
- 10. Latch/unlatchrelays
- 11. Counters
- 12. Comparators
- 13. Ladder logic
- 14. FlowTotalization/Integration
- 15. IntrusionDetection
- 16. TimeofDayControlw/Lockout
- 17. RampBlocks
- 18. DataLogging

(i) PLCProgramming

PLCprogrammingshallbecarriedusingFBD.Thelogicshallbeprepared usingproprietary programming software and shall be comprehensively

annotated with subroutine and rung comments to assist further development and maintenance.

Thesystemshallsupportasimpleprogrammingoftheapplicationsoftwareco mplywithIEC 61131-3.

Thesystemshallsupportastructured,modularprogramming.Atleastthefollo wingstandard operations shall be applicable:

(1) Logicfunctions(suchasAND/OR/ANDNOTetc.);

(2) Timerfunctions(externallyadjustable);

(3) Counterfunctions;

(4) Skipfunctions;

(5) Comparisonfunctions;

(6) Limitvaluefunctions;

(7) Arithmeticfunctions;

(8) Physicalunitfunctions;

(9) Closed-loopfunctionssuchasP/PI/PID/etc.

TheContractorshallsubmitthelogicdiagramsforreview.TheContractorsha llincludethe as-built logic in the final submission.

(j) **ProgrammingUnit**

Theprogrammingunitshallbeoftheportabletype,industrialmodeldesignedto beused during commissioning on site. A functional keyboard which supports different type of programming methods shall be included, as well as a CRT or TFT display

Atleastthefollowingfunctionsshallbe included:

(1) On-lineprogramming

(2) Off-lineprogramming

(3) Flexiblecorrectionsduringinput

(4) Fullscreeneditingfunctions

(5) Absoluteandsymbolicprogramming

(6) Inputofcommentsandtitleblocksforcompletedocumentation

(7) Completeapplicationsoftwaredocumentationfunctions.Printoutsof applicationsoftware logic functions shall preferably be in Ladder logic diagrams.

(8) Loadandtransferfunctions

The computer shall be provided complete with proprietary PLC programming. Communications cablesrequiredtointeractwiththePLC(Eg:ModbusCable)wouldbesuppliedbyth econtractor. The software shall provide facilities for:

- Carryingoutprogramrevision management;
- Insertionofcomprehensiveprogramsubroutineandrungcomments;
- Searchandfindandsearchandreplace‘contacts’and ‘coils’;
- Simulationfunctionsandtestingoftheprogrambychangingthestatusofcontac tsand monitoring the outputs;
- Preparationofcoilandcontactlistandtheirlocationsandmemorymaps;
- Makesystembackupcopieswhilethesystemis online;
- UploadanddownloadprogramstothePLCon line;
- Carryoutonlinemaintenanceandfaultfindingonthe PLC.

Note:-
ThePLCProgrammingSoftwareshallbeinstalledonaseparateEngineeringWorkstati on (EWS) system with industrial console units with chairs.

SUPERVISORCONTROL&DATAAcquisition(SCADA)or HUMANMACHINE INTERFACE SYSTEM (HMI)-

SCADA / HMI:

The SCADA / HMI shall be a fully integrated microprocessor based control which will monitor, control, display, record and trend all assigned plant inputs and outputs. The SCADA / HMIshall be a operated from industrial based 32’’ Operator Work Station (OWS) such that reliable and automatic plantcontrolcanbeachieved.Themainprocessmonitoringandcontrolshallbebymea nsofSCADA
/
HMIscreenasabasedprocessoperatorworkstationsthatshallbeinstalledonbackupo fthe Instrumentation Control Panel (ICP).

Failureofasingleoutstationorcommunicationstothatoutstationshallnotaffectcontroloroperation of any other outstation, unless the failed outstation provides essential data to another outstation, in

whichcasethenon-failedoutstationsshallreverttoafail-safemode.Analarmshallbegenerated whenever a communications system failure occurs.

3.16.1.j.1Hardware

Thesystemshallsupporthardwareandsoftwareinterconnectivitytoothernetworksgenerallyin accordance with the ISO Open System Interconnect 7 layer reference model.

Computer:

1. The Operator Work Station (OWS)configuration for 1 no. of SCADA / HMI System is as follows:
   OperatorStationincluding,Corei513thGenerationprocessor,12GBRAM,1TBSSD,RS 232/485/RJ45 Port, 1 Parallel Port, 4 nos. USB Port, 2x Ethernet Cards, Keyboard, Optical mouse, 32'' LED monitor, Latest windows professional & MS Office, Anti Virous, etc. - 1 nos.

2. The Engineering Work Station (EWS) configuration for 1 no. of SCADA / HMI System is as follows:
   EngineeringStationincluding,Corei5processor,8GBRAM,1TBSSD,RS-232/485/RJ45Port,1 Parallel Port, 4 nos. USB Port, 2x Ethernet Cards, Keyboard, Optical mouse, 18'' LED monitor, Latest windows professional & MS Office, Anti Virous, etc. - 1 no.

3. All workstations, servers, communications equipment and peripherals shall be from reputed manufacturers, suitable for continuous operation and shall be the most currently available modelsat the time of construction, subject to approval. Adequate spare capacity shall be included to meet the specified requirements and future expansions.
4. Thesystemshall support hardware and software interconnectivityto external Programmable Logic Controllers (PLC’s) over an RS-232/RS-485 serial data link using Profibus / Modbus, Ethernet or similar protocol, subject to the approval of the Engineer.
5. DataStorage:

   Ahistoricaldatastoragesystemwithremovablemediaforarchiveandbackupwillbe provided.

   The data storage system shall store alarms and events, with the time of

occurrence for one month
andselectedanalogueSignalsconnectedtothesystem.Allalarmsandeventsshallbe
archivedina first in first out buffer, for a period of 40 days.

Ahighspeedbackupdevicewithremovablemedia,suchasstreamingtapecartridgeoropticaldisk, shall beprovided for backingup the whole systemon a weeklybasis.Data selected for archive shall bewrittentoremovablemediawhichshallbesizedtosupportatleast40daysworthofarchive data.

AtleastoneDVDwrite/rewrite/readwith +Rand-RcapacityinadditiontothehistoricaldatastorageA

Monthlydutycycle	Upto40,000pages

Footnotefordutycycle	Duty cycle is defined as the maximum number of pages per monthofimagedoutput.Thisvalueprovidesacomparisonof product robustness in relation to other LaserJet or Color LaserJet devices, and enables appropriate deployment of printers and MFPs to satisfy the demands of connected individuals or groups.
	PaperHeading:
Paperhandlingstandard, input	50sheetmulti-purposetray1,250-sheetinputtrays2and3,50- sheet ADF
Paperhandlingstandard,output	150-sheetface-downoutputbin
Envelope capacity	Upto30envelopes
Envelope feeder	No
Duplexprinting(printingonboth sides of paper)	Automatic(standard)
Documentfinishing	Sheet-fed
Mediasizes,standard	Letter,legal,executive,envelopes(No.10, Monarch)
Mediasizes, custom	Tray1: 3x 5to8.5 x14in;Tray2,Tray3: 3.94x 5.83to8.5x 14 in
Media types	Paper(bond,brochure,colored,glossy,letterhead,photo,plain, preprinted, pre-punched, recycled, rough), transparencies, labels, envelopes
Mediaweight	Tray 1: 16 to 47 lb (up to 58 lb with Color Laser glossy photo papers);tray2,tray3:16to43lb(upto47lbwithpostcards,up to 58 lb withColor Laser glossy photo papers)
Weight	71.2 lb
Processorspeed	450 MHz
Memory,standard	160 MB
Memory,maximum	416 MB
	ScannerSpecification:

Scannertype	Flatbed,ADF
Scanresolution,optical	Upto1200dpi
Bit depth	42-bit
Scansize,maximum(flatbed)	8.5 x 11.7in
Scansize,maximum(ADF)	8.5 x 14in
Scanspeed(default)	Upto15 ppm
Automaticpapersensor	No
	Copier Specification:
Copyspeed(black,bestquality, A4)	Upto20cpm
Copyspeedblack(best,letter)	Upto20cpm
Copyspeedcolor(best,letter)	Upto20cpm
Copyresolution,black	Upto 600x 600 dpi
Copyresolution,color	Upto 600x 600 dpi
Copyreduce/enlargesettings	25 to 400%
Maximumnumberof copies	Upto99copies
	Fax Specification:
Faxing	Yes
Faxtransmissionspeed(seconds per page)	3secperpage
Fax memory	Upto250pages
Faxnote	BasedonstandardITU-Ttestimage#1atstandardresolution. More complicated pages or higher resolution will take longer and use more memory.

Faxresolution,black(dotsper inch)	Upto 203x 196 dpi
Speeddials,maximumnumber	Upto120numbers
Auto redial	Yes
Faxdelayed sending	Yes
Fax broadcast	119
Junkfax barrier	Yes
Polling	Yes(receive only)
Remoteretrieval	No
Fax forwarding	Yes

SystemOverview

The Industrial HMI system shall follow the International Standards Organization (ISO), Open SystemsInterconnect(OSI),referencemodelguidelines.Allcentralsystemhardware andsoftware devices shall be interconnected using a bus topology data highway. The communications protocol used shall generally meet the requirements of the ISO.

The systemshall provide efficient and safe operation of the pumpingprocess plant bydetectingalarm anderrorconditions,alertingtheoperatortotheseconditionsbothvisuallyandaudibly ,monitoringall important system parameters and providing facilities for plant optimisation. The system will allow operators, technicians and engineers to issue commands to change system parameters, start and stop equipment, provide configuration tools and operate diagnostic facilities from HMI and Engineers Terminal (ET), after successful log-on by security password.

TheHMISystemshallperformallthenecessaryfunctionsfortheoptimummonitoring, controland operation of the entire system.

For each abnormal condition, Plant failure, Plant unavailable or failure to respond to a command withinagivenperiod,theHMIshallprovidetheappropriatealarm.Printedandarchive

dalarmsshall be time and date stamped for occurrence and acceptance. Alarms, logs and reports shall be output to

separateprinters.Alarmsshallbeinred.Theabilitytogeneratealarmswithinthesyste msoftware based upon digital and / or analogue events and set points shall be provided.

Analarmhornwithsilencebuttonshallbeprovidedtoalerttheoperatorofanalarmcondition.

Specificalarm,monitoringandcontrolinput/ outputrequirementsshallbedeterminedfromthe particular control specifications and the Project Drawings.

SCADA/HMIsoftwarefunctions

(a) General:

1. The Contractor shall be responsible for supplying complete software packages to enable the equipment to operate as stated in this specification. Provision must be made for the adding of furthersoftwaretasksasandwhenrequired.Allsoftwarefunctionsshallbeuserf riendly,with instruction and messages to aid the operator. The Contractor shall make available all standard software functions, even if not specifically detailed in the specification.

2. Thecomputersshallutilizearealtimemulti-taskingandnetworkedoperatingsystemwithaproven track record in real time control applications.

3. The Operating System shall be compatible with Automation software's such as Windows 11, loadedwithMS-Officelatestlicensedversionsuitableforinterconnectionwithexternalnetworks in a Wide Area Network (WAN) configuration, where specified.

4. The Application Software shall provide communication with other industrial standard open networks.TheSoftwareshallsupportObjectLinkedEmbeddingforProcessContr ol(OPC).OPC should be an in-built feature of the software.

   TheSystemshallsupportfullydistributed64bit Client/Server architecture.

   TheSystemshallincludeVisualBasicforApplications(VBA)asabuilt-inprogramming language. Facility shall be available for building custom objects using VBA.

Objectorientedgraphicsandtoolstoeasilybuildreusablecontrolstrategies.

ODBCApplicationProgramInterface(API)capableofcollectingandwritingsecurer eal-time electronic records to one or more relational database.

ThesoftwareshallsupportOPCstandardsasbothaclientandaserverforfastandreli able communications with a wide variety of hardware devices.

ProvideActive-Xcontrolswithselectionofthird-partyActive-Xcontrolsforready-madesolutions without VBA programming.

TheHMIsoftwareshalluseSQLserverastheintegraldatabase.

Astandardsoftwarepackage,suchasCrystalReportshallbeprovidedtofacilitategenerationof free format, intuitive and presentation quality reports.

TheEngineeringWorkstationshallbeprovidedwithsimulationtoolstosupportoff-linetestingof the control logics.

TheServershallprovidethemasterclockfortheHMItime synchronization.

ThesystemsoftwareshallbefromtheHMIequipment manufacturer.Thirdpartysoftwareisnot acceptable.

It isarequirement thatthesystembesupportedbyonlineconfigurationandeditingofallVDU mimic displays and database and to create new displays and additional database.

Operational mimics and other graphics shall be presented in an industry standard graphical user interface(GUI)format.Aminimumoftwoactivewindowsshallbedisplayableconcurrently.Both text and graphics shall resize automatically to accommodate changes made to the size of a window. The system shall be designed to minimize the operator’s use of the keyboard.All major functions shall be accessible on-screen through use of the mouse or track ball.

Operatorsystementry,foreachareawillbepasswordcodedwithdifferentlevelsofentrydepending on the level of authority of the operator. Development and systems level entry passwords will be provided for engineering workstations. Each action taken by any operator at any level of entry, or at any operator terminal, shall be logfile recorded and time and date stamped. Login and out time and dates will be printed on the control room event logging printer.

VDUmimicswilldisplaydynamiccolourdetailsofflowratesandpressures,pumpstatus,welllevels, alarms, electrical power supplies and other general equipment status conditions.All requests and commands shall be via icons, whether menu linked or linked to equipment control actions. A permanentdynamicalarmbannershallbedisplayedatthebottomortopofeachoperatorscreen.Each control action will be routed through a series of confirmation routines.

Thereportsshallbeavailablefor printingingraphortabularformat.Dynamictrenddisplaysshall alsobeavailableforallanalogueflow,levelandpressurevalues.Custom,aswellas preconfigured

reportsandtrendsshallbeavailabletoahigherlevelofentry.Acolour,A4/A3size, screendump printer shall be provided for graph and trend prints.

Anoperatorhelputilityshallbeprovided,offeringhelplinkedtotheparticularactionb eingcarried out by the operator at that time. At least one help screen per screen page shall be available. This facility shall be preconfigured with an option for updating by operators, via a password entry.

TheApplication Server software shall beconfigurableto provideforthemonitoringand controlof all points,loops,andsystemsthroughgraphicdisplayscreensandhardcopyreports.Thes eshallinclude:

- ParameterDisplaysforsignalcontrol
- ControlLoopStatus Displays
- RealTimeandHistoricalDataTrend Displays
- EventDisplaysandLogReports
- AlarmDisplaysandLogReports
- EquipmentDiagnosticDisplaysandReports

Thesystemshallprovideon-linediagnosticsthatdisplaythecurrentstatusandoperationofthelocal area network and its nodes. The diagnostic display shall include the LAN adapter status for the machine showing the display, as well as the current number of messages, errors and retries.

Thesystemshallconformtoandtakeadvantageofindustrystandards.Theseshallinclu de,butnotbe limited to:

ODBC

OLE

ActiveX

COM/DCOM

DDE and Advance

DDE

Cprogramminglang

uage Visual Basic

MicrosoftWindowsXPorthemostcurrentOperatin

gSystem TCP/IP

OP

C

XM

L

(b) DisplayFacilities:

Thedisplaysshallbeuserconfigurable,withtheuserbeingabletoconstructanydesiredsymbolfor display. Any display shall appear (excluding historical recall) within 1 seconds to 3 seconds of selection and the displayed data shall be updated from the database .Alarms shall typically appear within 3 seconds to 5 seconds of occurrence and within 1 second of being received into the central system database.

The Contractor shall configure all display pages as fully as possible. However, facility must be incorporatedtopermiteasyconstructionandmodificationofthedisplaypages,byusingastandard library of shapes and symbols. The library shall be added to and modified by the user as required. The configuration shall be object orientated for ease of use.

Theinitialapplicationsoftwareshallprovideforthedisplaypageslistedbelowandanypages necessary for the system to function as a complete entity.

a. Mimicdisplays.

b. Graphicdisplays.

c. Trenddisplays.

d. Alarmsummarytableswithdateandtime.

e. Eventlogsofpast72hourswithdateandtime.

f. Tabulardisplayofdata.

g. Insetwindowsshowinganaloguetrendsmaybemixedwithmimicdisplays.Insucha displaythemainmimicandinsettrendshall all belivewithautomaticdisplayupdates.

Indexingofinformationandmenusshallbepresentedintheformofactivewindowsonth

escreen, while the mimics etc. are still available for view.

No display or function shall effect the logging/monitoring of data. It shall be possible for the master stationterminalandauxiliaryterminalstoperformsimultaneously,differenttaskswithinthedisplay.

Monitoringand Alarms

1. Theoperatorshallbeable tomonitoralloftheinformationattheworkstation.Heshallbeableto view active equipment information on a series of VDU based graphical and tabular displays.

2. Intheeventofanequipmentalarm,thefollowingshalloccuratthemaster station:

a. Alarmmessagedisplayedinthealarmmessageareaofthe screen.

b. Theaudiblealarmshallsound.

c. TheappropriateSectionofthedisplaypageshallchangecolourandflash.

d. Afullmessageshallbewrittenonthealarmpage.

e. Thefullalarmmessageshallbeprintedonthealarmprinter.

f. Thefullalarmmessageshallberecorded,storedondiskandautomaticallyarchived.

3. The operator should be able to acknowledge the alarm by pressing an accept alarm key or icon. Thisactionshallstopflashingofallassociatedalarmmessagesanddisplays.However thedisplay shall remain in the alarm state fixed colour to indicate an accepted alarm. When all outstanding alarms have been acknowledged the audible alarm shall be silenced.

4. Oncethealarmhascleared,themessagesanddisplaysshallreturntonormal.Theal armmessage shall stay recorded on the event/alarm log and an alarm cleared message shall also be recorded.

5. Ifthealarmclearsbeforebeingacknowledgedthesequenceofeventsshall continueasabove except the message shall change to indicate a cleared alarm.

6. Anaudiblealarmsilencefunctionshallbeprovidedtoenableanoperatortosilenc

etheaudible alarm without acknowledging all alarms. On occurrence of any subsequent alarm, the audible alarm shall sound.

7. Eachsignal withintheconfiguredsystemshall becapableofbeingassignedanalarmbasedonthe following:

a. Fourlevelsperanalogue(LoLo,HiHi,LoandHi).

b. Rateof change.

c. Deviationfromsetpointorothercontrolparameter.

8. Alarmsshallbetimetaggedto1secondresolutionatthe I/O's.

9. A minimum of four alarm priorities shall be provided so that those requiring immediate attention maybeseparatedfromalarmsoflowerpriority.Anaudiblealarmshallsoundforalarmsrequiring operator action.

10. Typicalalarmassignmentsareas follows:

a. criticalalarm- - analarmthatrequiresimmediateoperator action

b. non critical alarm - analarmthatrequiresoperatoractionbutnotnecessarily immediate action

c. operatorguidealarm - analarmthatprovidesinformationtothe operator

d. event - alowpriorityconditionwhichisrecorded.

VDUMimicDisplays(SCADAScreens)

TheContractorshallconfigureallthemimicstoprovidetotaldetailedcoverageofthemonitoringand controlofequipmentasdetailedinthisspecification.It isexpectedthatdisplaymodificationswill be required in the future and therefore the ability to change the displays without programming skills is essential.

Instrumentation shall be displayed using ISO standard symbols. For mimic configuration, it shall be possibletocallupalibraryofstandardsymbolsrepresentingitems(e.g.pumps,valves) andaddnew symbols tothelibrary. Buildingmimics shall be simple and be achieved byusinga mouse or tracker ball pointing device. The mimic displays shall consist of the following pages:

a. Ageneraldiagramcoveringthewholeofthesystemonasinglescreenwithkeydata

b. Ageneralblockdiagramforeachsiteorareaof Siteshowingtheequipmentdisplaye donaseries of single screens with key data.

c. Mimicoftheequipmentandinstrumentationconnected toeachIOmoduledisplay edonasmany screens as necessary.

d. SCADAscreensshallincludescreensforISPSunderthiscontract.

Trend Displays

It shall be possible to plot dynamically updated real time data and archived data on a line graph, to representanalogueordigitalinformation.Eachgraphshallbecapableof displaying8plotsoverlaid onagraphofdifferentcoloursandlinetexture.Nexttothegraph,thereshallbeakeyrel atingeach colour to its function. The horizontal axis shall be time based and user selectable in minutes, hours, days, weeks, for example, together with a start time.

Thevertical axisshall bescaledasapercentageofrangeandbedisplayedinthecolouroftheselected reading. To avoid cluttering, the vertical axis scale shall be changed by selecting the individual display. The vertical axis shall be automaticallyscaled for each selected point, between limits entered by the user.Actual values in engineering units shall be displayed by positioning a cursor at the desired point of the trend graph.

Thedisplayofthedatashallalso beavailableintabular form.

(a) ManualDataEntry:

1. Thesystemshallbeprovidedwithfacilityforenteringdatamanuallyviathekeyboa
   rd.Thisdata will fall into two types:

a. Constantswhichwillbechangedinfrequently.Thisdatamayhavetimeanddateassociatedwithit.

b. Maintenancerelatedcomments.

(b) ManuallyCorrected Data:

Thesystemshallallowapersonwithauthorizedaccesstocorrectmanually,erroneousdataviathe keyboard.

Reports

There shall be a real time spreadsheet facility supplied and installed by the Contractor in the HMI station. The users shall be able to transfer data from either the archive system or live data to the spreadsheet.Theusershallbeabletoproducedaily,weekly, monthlyandannualreportsusingany data and a mixture of formats (tables, graphs, summaries, spreadsheets).It shall be possible to generate reports, either automatically at predetermined intervals, or manually on demand by the Operator.Typical reports on a minimum would be:

a. Flowratesandtotal.

b. Failuresofequipment.

c. Wetwellandtanklevels.

d. Dischargepressures.

e. Maintenanceschedules.

f. Processalarmconditions.

Profiling

From an average, typical or manually entered plot, it shall be possible to set an exception profile wherebyreadingswithinanupperandlowerlevelareacceptable.Profilesshallbesetgraphicallyvia OW.The user may select for the system to alarm if the reading is outside the profile and highlight such exceptions as part of a report, thereby reducing the need to examine all data, to ensure acceptability. The number of exceptions shall be logged.

Data Manipulation:

Itshallbepossibletoperformsimplemathematicalfunctionsonanydata,includingthefollowing functions:

a. Addition

b. Subtraction

c. Multiplication

d. Division

e. Squareroot

Itshallbepossibletolog,displayoruseinacontrolloop,theresultantdata.

DatabaseQueryFacilities:

The system shall support the use of database relationships and wild card characters to provide databasequeryfacilities.Itshallbepossibleforapplicationsintegrationtoconfigurequerieseasily and save them for future use.Support of Dynamic Data Exchange (DDE) or Structured Query Language (SQL), to permit data exchange between the PLC and external applications, including spread sheets and databases shall be provided.

Datashallbepresentedintabularformatandcontainanycombinationoffieldsfromthemainsystem database. It shall be possible to manipulate the data by specifying search and sort criteria to define data range limits. Once a query table has been created, it shall be possible to store the configuration and initiate successive look-ups, using a point and shoot technique.

DownloadingIOConfiguration:

ItshallbepossibletodownloadconfigurationtotheIO'sfromtheEngineer'sterminalandthe Portable Programming Unit (Laptop)

Diagnostics:

Thesystemshall haveon-linediagnosticfacilitiestoreportsystemfaultsastheyoccur.Aset ofoff- line diagnostic routines shall be supplied for more extensive fault diagnosis.

SecurityAccessLevels:

Thefunctionsavailableonthesystemshall befullyflexiblesoastoallowusersaccesslevelstobe customised by the system operator, to suit individual user requirements.

Access to management and engineeringlevels shall be restricted by user selectable passwords or key switch.Thesecuritysystemsshallbebasedonasetofprivileges,whichmaybegranted ordeniedto individual uses by the system operator.

Thesecurity/accesslevelswouldbedividedbetweenengineers,supervisorsandoperators.

Thesystemshallbeprotectedfromun-authorizedchangestotheoperatingsystemandapplication programs.

Thesystemshall prevent un-authorizedusersfromre-bootingthesystemorabortingorsuspending system-related programs.

The system shall provide three levels of operator access to the system as a minimum, with the first levelpermittingaccesstoviewingselectedplantconditionsasdescribedbelowandthe highestlevel intended for the system manager.

Amechanismshallbeprovidedwhichpreventsusersoperatingatalowerlevelfromaccessing functions assigned to a higher level.

Thesystemshallprovideapassword-protected,userlog-onfacilityfordefinitionoftheuseraccess level. It shall be possible to define a minimum of eight privilege levels.

Passwordsenteredduringthelog-onprocessshallnotbeprintedor displayed.

Thesoftwareshallmonitortheactionsoftheusercurrentlyloggedonateachnodeands halllog the current user off after a definable extended period of no operator interaction with the system and produce a printed log-off message.

Loggingoffoftheusershall notshut downthesystem.

System-generatedlogmessagesrelatingtooperatoractions,suchasalarmacknowledgement sorset- point changes, shall include the identification of the current logged-on user.

TheContractorshallprovidethefollowingdefineduseraccesslevelsasaminimumand additional levels as instructed by the Engineer:

1. **Defaultlevel**:

Thedefaultlevelshallpermituserstoviewalldisplaysexceptthosespecificallyassigndtoahigher level of access.

2. **Operatorlevel**:

Theoperatorlevel shall permit authoriseduserstoaccess defaultlevelactivitiesinadditiontothe following:

(a) Performcontrolactions;

(b) Acknowledgealarms;

(c)Enterormodifymanuallyentereddataforinclusionintoreports.

3. **Systemmanagerlevel**:

Thesystemmanagerlevelshallpermitauthoriseduserstoaccessdefaultlevelandoperatorlevel activities in addition to the following:

(a) Modifyalarmandcontrolsetpoints,deadbandsandtime delays;

(b) Enterormodifyhistoricaldata;

(c)Add,deleteormodifyindividualI/Opointsorpointattributes;

(d) Add,deleteormodifyfielddevice configurations;

(e) Create,deleteormodifycontrolalgorithms;

(f) Create,deleteormodifygraphicdisplays;

(g) Create,deleteormodifysystemreports;

(h) Configuretrenddisplays;

(j) Accesstheoperatingsystem;

(k) Assignaccesslevelsanduser passwords;

(l) Performanyothersystemmaintenance function

Programming:

ThemethodofprogrammingwilldependupontheManufacturerssystemrequirements.However,the following standards shall be followed:

a. Allprogrammesshallbewrittensuchthattheylendthemselveseasilytoalterationsandadditions.

b. Goodprogrammingpracticeshallbefollowedusingstructuredprogrammingtechniques.All programmesshallbetidyinformatandlogicaltofollow.Programmesshouldbe extensively annotated with comments and be self-documenting.

c. Thesystemshallbesuppliedwithprogrammesthatuseahighlevellanguage.

Programme– Documentation:

Aspartoftherequirementsofthisspecificationfulldocumentationisrequiredasbelow:

a. Softwareusermanuals

b. Databasepointallocationtable

c. Completeprogramlisting,flowchartsforallsequencesandcontrolroutines

d. Applicationsoftwaresourcecode

e. Enduserlicense agreements.

InterfacetotheJayanagar,BangaloreCentralSCADAMonitoringCentre(CSMC)

(a) General

Data from the treatment works is required to be passed to the Central SCADA Monitoring Centre (CSMC) located at 2nd Floor, BWSSB New Building, 11th Main, IVth T Block, Jayanagar, Bangalore,Bangalore.AredundantwirelessGPRSgatewayshallbeusedtotransmitandreceivethe operational data to 2nd Floor, BWSSB New Building, 11th Main, IVth T Block, Jayanagar, Bangalore.

(b) InteroperabilityTest&Integrationco-ordination:

TheISPS contractor shall conduct a interoperabilitytest to confirm &demonstrate thatthe control system data can be read & written by the SCADA Master Control centre using appropriate OPC server&clientsoftwareviatheinterfacepanelandlocalPLC/HMI.Thetestshallbecarriedoutin presence & co-ordination with the Master SCADA control centre contractor/system integrator.

ItisrequiredthattheISPScontractormapshislocalI/O'sforintegrationinthesameformatas required at SCADA Master Control centre.

TheISPScontractorshallco-ordinatefullywiththeSCADAMasterControlcentrecontractorfor integration tests .The ISPS contractor shall be fully responsible for data to be made available at SCADA Master Control centre.

Note:-

i. The ISPS SCADA / HMI data shall be provided by ISPS contractor for wireless data communication from ISPS to downstream STP control room. The ISPS contractor shall be fully responsible for process data to be made available at downstream STP control room.
ii. ISPS process data to master control centre (MIS-II) and downstream STP those wireless network communication charges bourn by the same ISPS contractor during Installation, Testing, commissioning and O&M periods.

ControlRoomFurniture

InadditiontotheSCADA/HMIsystemequipment,theContractorshallprovidefurniture(system console) to

complement or match both the color and styling of the equipment. Control room

FurnitureshallcomplywithrelevantIECstandardsforergonomicdesign.Detailsofthe controlroom furniture shall be submitted to the Engineer for approval.

TheContractorshallprovidetwofabric-coveredupholsteredswivel-typeadjustablearmchairswith casters, a rigid and lockable steel cupboard for the storage of operating and maintenance manuals, drawings, logger paper, charts, disks and the like.

SparesforPLCandHMI Component:

Contractor shall provide all the services and supplies in accordance with approved procedures for handlingofspareparts,whichshallincludearrangingfortheirproperreceipt,stacking andstorage.

(a) SparesforCommissioning&Start-up:

Contractor shall identify, define, procure, and supply construction, pre-commissioning, commissioningandstart-upspares,specialtoolsandhandlinggearforeachitemofequipment.

Onaminimum,1PLCCPU,1DIModule,1DOModule,1AIModule,1AOModule,communication module(including wireless GPRS gateway) ,remote telemetry unit, fuses of each type and size installed.

(b) Spareslistfor1st YearofOperation:

Contractor shall identify, define, procure, and supply construction, pre-commissioning, commissioningandstart-upspares,specialtoolsandhandlinggearforeachitemofequipment.

These items and quantities should be subject to BWSSB’s approval. Upon completion of commissioning,contractorshalltakeinventoryandensurethatsparesforfirst yearofoperationas identified and defined are available on site.

(c) SparesListforsubsequent2YearsofOperation:

Contractorshallidentifyanddefineforthesubsequent2yearsofoperation,sparepartsforeachitem of equipment.

(c) SparesListforsubsequentyearsof operation

Contractorshallidentifyanddefineforthesubsequentyearsofoperation,sparepartsf oreachitemof equipment as necessary.

Note:ContractortoincludeSparelistduringtheirbidsubmissionbasedonthe manufacturers recommendation for each item of equipment proposed.

FunctionaldesignspecificationforPLCand HMI

The Contractor shall submit a complete functional design specification (FDS) for approval by the Engineer within 3 months of the award of the contract. Separate FDS shall be submitted for ISPS underthiscontract.Thisdocumentshallserveastheprimarymechanismbywhichthe Engineermay confirm that the Contractor possesses an accurate understanding of the system and its control requirements.The Contractor is encouraged to obtain clarificationsandto suggestrefinementstothe control descriptions contained in this Specification.

The FDS shall comprise an overall description of the plant,its functioningand control, and a detailed description of each section of the control systemcovering modes of operation, manual overrides, set- point and parameter selection and adjustment. The detailed description shall include a step-by-step controldescriptionwhichdefinesthefunctionofeachpieceofequipmentandeachcont rolactionand interlock, including details of the program in each programmable item.

TheFDSshalldescribethe‘fail-safe’featuresincorporatedintothedesignfortheeventoffailureofa plant item or system, or loss of an input signal affecting a control loop or process sequence.

TheFDSshalldescribecontrolactionstakenandmonitoringfunctionswhichremaina vailableduring a power failure, and any automatic controls or sequencing which take place during system start-up and shut-down.

TheFDSshallbepresentedinaclearandprecisemannerandshallincludefiguresordra wingswhere appropriate.

TheContractorshallsubmitandobtainapprovaloftheFDSfromtheEmployer’sRepre sentative before beginning the detailed control system design. The contractor should take note of the importance of this obligation.

SubmissionsbytheContractor

ThesubmissionsbytheContractorpertainingtothePLC&HMISystemshall

comprisethefollowing as a minimum:

(a) A functional design specification (FDS) for the SCADA / HMI system. This shall be combined withtheFDSforinstrumentation,controlandautomationtoformacompletedocumentandshall comply with the specification of the FDS for instrumentation, control and automation. This document shall serve as the primary mechanism by which the Engineer may confirm that the Contractor possesses an accurate understanding of the system and its control requirements. The Contractor is encouraged to obtain any necessary clarifications and to suggest refinements to the control descriptions contained in this Specification.

The FDS shall include a detailed block diagram of the PLC & HMI system with a description of thecommunicationsschemetobeprovided.TheFDSshallincludeoperationaldetailsoftheHMI system which have an effect on plant operations, such as power failure response, communication failure response, and automatic shut-down and start-up of the system.

TheFDSshallincludeadescriptionoftheinterfaceoftheHMIsystemwithanyexisting or planned future DAC equipment.

TheContractorshallsubmitapreliminaryFDSandobtainapprovalbeforethesystemarchitecture design is finalized or detailed design takes place. The Contractor shall formally notify the Engineer for approval of any amendments or additions to the approved FDS. The final FDS shall be submitted for approval before submission of the factory acceptance test definition documents. The Contractor should take note of the importance of this obligation.

(b) LayoutdrawingsforeachpieceofequipmentfabricatedorassembledbytheContractor,showing the position of each component with required clearances where applicable, and with overall dimensions.

(c)Wiring diagrams indicating each component of the system and all wiring and cabling thereto, showing manufacturers, types, duties, ranges and nomenclature, referencing the P&I diagram whereapplicable,withinputs,outputs,cablewiringandterminalidentifications clearlymarked.

(d) Mimicvideodisplaysintheformofhardcopiesorphotographswhichareclearlylegibleandare notated to indicate dynamic data and control pick points where

applicable.

(e) Controlvideodisplaysintheformofhardcopiesorphotographswhichareclearlyle gibleandare notated to indicate dynamic data and control pick points.

(f) Logicdiagramsofplantoperationandcontrolsysteminteraction(includingmode soffailureand shutdown routines) along with Operation & Control Philosophy.

(g) Completeinputandoutputlistand InstrumentListgivingtype,circuitnumber,tagname,short description, outstation, database reference, associated field device, range (if applicable), critical/non-critical alarm status and the like.

(h) Descriptionofqualitycontrolmethodsandapprovals.

(i) Detailedworksandacceptancetestprocedures.

(j) Programmeformanufacture,delivery,installationandcommissioning.

(k) Appendices,asnecessary,toincludemanufacturer's literatureforeachitemofequipment supplied.

(l) Operationandmaintenancemanualsdetailingthefollowing:

- Generaldescriptionandoperatingprinciples;
- Technicaldescriptionoftheequipment(manufacturer's standardbrochuresonlybeingacceptableif the particular item of equipment described is clearly designated, adequate information is supplied, and irrelevant information is deleted or otherwise delineated)
- Completeoperatinginstructionsdefiningthesequenceofoperations,includingflowcharts;
- Proceduresfordismantling,cleaning,servicing,replacingpartsandreassembling,including recommended clearances and tolerances;
- Detailsofallinstrumentandequipmentsettingsasapplicabletothiscontract;
- Maintenanceandlubricationschedules;
- Faultdiagnosisprocedures;
- Datedandpricedlistofsignificantsparepartsandspecial tools,includingidentificationnumbers and sources of supply;
- Simplifiedarrangementdrawingsshowingallcomponentsoftheequipment.

(m) Generaloperatingmanualcomprisingthefollowing:

- Generaldescriptionandoperatingprinciples;

Operating instructions for normal procedures in a step-by-step format including control operations, requirementsfordisplayorprintingofdata,performancemonitoring,responsetoalarmsorfailures, changing of operational parameters, and manual data entry.

(n) Systemback-upsoftwarecomprisingthefollowing:

•Applicationprogramsoftware;

•Operatingandutilitiessoftware;

•Systemconfigurationsoftwareincludingdisplaysandoperationalplantdata.

SoftwareDocumentation

TheContractorshallprovidecompletesoftwaredocumentationforeachProgrammablepieceof equipment. The material to be provided shall include, as a minimum:

(a) Allofthemanufacturer’sstandardspublishedreferencematerialsanduser’sguides.

(b) Originalofalllicenses,thelicensesshallhave(MinimumTagswillbeof1000after thatcanbe expandable to 500 Tags).

(c)Completedocumentationforanypackagedsoftwareincorporatedintothesystemincluding software written by other manufacturers.

(d) Aworkingcopyandcompletedocumentationforanyprogram-developmentsoftwareusedforthis project.This software and documentationshall be of the same versionand revision numbers used for development under this contract.

(e) Aworkingcopyandcompletedocumentationforanydatabasemanagement,reportgeneration, screengraphicbuilderorothersimilarsoftwareusedfordevelopmentunderthis contract.This software and documentation shall be of the same version and revision numbers used for development under this contract.

(f) Hard-copy documentation of all configuration data, all user-accessible source code including controlprogramcode,reportsanddatabasecontentsincludinglistings.Allprogramlistingsshall be clearly and completely commented so as to convey to the

reader a full understanding of the function of the program. So-called ‘self-documenting’ code without additional, supplementary comments will not be acceptable.

(g) A complete input and output list giving type, circuit number, and tag name, short description, outstation,databasereference,associatedfielddevice,range(ifapplicable),critical/non-critical alarm status and the like.

(h) ASoftwareSystemSpecificationdocumentwhichdescribesallcontrolprograms furnishedwith the system. Design documentation shall include, as a minimum:

•A description of the software development environment, including development procedures, limitations,restrictions,configurationmanagement,documentationstandards andcompatibility;

•Anoveralldescriptionofthesoftwaredesign, includingapplicationstructureandsubsystem divisions, control strategy, monitoring and display hierarchy, data acquisition and storage, notational and operational conventions and operator access restrictions;

•Adescriptionofeachapplicationsub-system;

•Aflowchartor‘pseudo-code’descriptionofeachprogrammoduledetailingtheflowofcontrol throughout the module;

•Alistoffilesusedbythesystem,includinglocationandabriefdescription.

Drawingsandschedules

Thecontractorhastosubmitthefollowingsetofdrawingsduringbasic&detailenginee ringperiods and those are:

(a) Processandinstrumentationdiagram

(b) Generalarrangementdrawingsoffield-mountedinstrumentsshowingInstallationdetails.

(c)Generalarrangementdrawingsofinstrumentandcontrolpanels,fullydimensioned

Inplanandelevationviews,showingfoundationandfixingDetails,accessdoors,cleara nces,cable- entry positions, weight and lifting arrangement.

(d) Layoutdrawingsofpanelfasciasshowinginstruments,controlsanddetailsofalllabels.

(e) Layoutdrawingsofpanelinteriorshowingequipment,terminalblocksandCableways.

(f) AlarmSchedule.

(g) Internalcircuitandwiringdiagramsforinstrumentandcontrol panels.

(h) Schematiccontroldiagrams.

(j) Instrumentloopdiagrams.

(k) Instrumentwiringandpipingdiagrams.

(l) Interconnectionwiringdiagrams.

(m) Cableblockdiagrams,drawingsand schedules.

(n) Instrumentsystemandpanelpowerdistributiondiagrams.

(p) Programmable-devicefunctionaldesignspecificationswhichshallincludeHardwaredetails,logic flow charts, ladder diagrams and program listings.

(q) Schedulesofinputstoandoutputsfromprogrammablecontrollersand Telemetryoutstations.

(r) Labellingschedules.

(s) Comprehensivetestingschedulesforalloff-site,on-site,pre-commissioning,Commissioningtests and take-over tests.

UninterruptiblePowerSupply (UPS)

TheUPSshallbefloormounted; selfcontainedandmetal cladandshall besuitableforsupplyinga nonlinearloadwith60minutesbatterybackup.Itshallbepossibletoopentheenclosurefrontdoor when the unit is in use without exposing any live contact to touch.

The UPS shall be an on-line type incorporating a six pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch which shalloperateintheeventofUPSfailure,overloadormanualinitiationinordertotransfertheoutput supply to mains without disturbance to the output supply.

TheUPSshallincorporateadcunder voltagetripcircuittoelectronicallytriptheUPSoutput inorder to protect the batteries.

Thenoiseleveloftheunitshall notexceed60dB(A)at1mfromtheUPScabinet.

Theoutputoftheinvertershall be asinewavehavinglessthan2%THDforlinearloadsandless than 4% for 50% non linear load. It shall be suitable for load power factors 0.7 lag to 0.9 lead.

Theunitshallhaveadynamicresponsesuchthata100%steploadcausesanoutputvoltagetransient of less than ± 4% with a recovery time of less than 4 ms.

Forthreephaseoutputunitstheoutputvoltageshallnotvarybymorethan±1%foranunbalanceof 10%.The load crest factor shall not be less than 3:1.

Theefficiencyatfullloadand0.8powerfactorshallbegreaterthan88

%. Indicators to indicate

- UPSstatus
- UPSalarmconditions

TheUPSshallprovideavoltfreecontactoutputto indicate:

- Warning,i.e.lowbatterycapacity
- Fault
- Staticbypassinuse.

The UPS shall have an overload capacity of 150% for 30 seconds and shall be protected in the event of a short circuit of the output. The batteries shall be housed, either within the UPS enclosure or within a separate matching battery cubicle suitable for location adjacent to the UPS. The batteries shallbemaintenancefreeleadacidtypesealedforlife.Batteriesshallbecontainedwithintranslucent impact resistant flame retardant polypropylene cases. They shall have life in service of at least 10 years. Terminals shall be shrouded to prevent accidental contact. The battery enclosure shall be corrosion resistant and ventilated to prevent the build-up of gases. Warning notices shall be provided for wall mountingto warnof the presence of charge gases.The batterysupplytothe UPS shall be via a fused load break switch disconnected circuit breaker. The battery recharge time to 90% of full charge shall be

approximately ten times the discharge time at full load.

TheContractorshallcarryoutspecifiedtestsasfollowsinadditiontoanytestsstatedor impliedby the foregoing sections of this clause. The tests shall be carried out on the fully assembled control panel containing the PLC and associated equipment in order to demonstrate correct functional operation of the hardware and software systems.

TheUPSshallbecompletewithIsolationtransformer,ConvertercumChanger,invert er,protections, indications, programming, microprocessor based monitoring and fault diagnostic system, communication facilities, control power supplies, SMF battery, accessories and interconnecting cables.

ThecapacityoftheUPSdependsuponactualLoadrequirementofInstrumentsandco ntrolsystem equipments in this case; the contractor shall furnish the detailed Load Calculation for all ICA equipmentstothe EngineerforfinalisationofthesizingoftheUPS.Howevertheminimumsizeof the UPS shall be not less than 5 KVA.

Note:

- UPSshallbeconsideredforFieldInstruments,ControlSystemsandPanelm ountedHMI Unit.
- Inputshallbe3-phase,4-wireforUPSrangingabove 5KVA.
- Inputshallbesingle-phase,2-wireforUPSratinglessthan 5KVA.
- EnclosureprotectionIP54.

UninterruptiblePowerSupplies(UPS)Testing

TheContractorshallcarryout specifiedtestsasfollowsinadditiontoanytestsstatedorimpliedby the foregoing sections of this clause.

Thetestsshallbecarriedoutonthefullyassembledunitutilisingthebatteriesthatareto besupplied with the unit.

TheContractorshalldemonstratethefollowingonaminimum:

- Change-overfromfullloadwithmainspresenttofullloadonbatterysupply;
- Carryoutadischargetestonthesystematfullloadandforthespecifieddutybridging time period;

- Carry out recharge test after operation for the specified duty bridging time at full load. The UPS shall supply the full load during the recharge cycle.
- DemonstratethefullfunctioningofthePLC&HMIsystemwhilerunningonUPSpower.
- All Routine/acceptancetests as per relevant Indian/ International standards shall be carriedout in the presence of Employer / his Engineer

QualityAssurance/QualityControl(QA/QC)

QA/ QVCshallcomplywiththeContract,withparticularrequirementsspecifictotheequipmentor service being provided as outlined below for PLC & HMI systems. The quality assurance/control procedures shall include, but not be limited to the following:

•ContinuityandWiringtests;

•InsulationandHighPotentialTesting;

•PackagingandShipping;

•Welding;

•Cleaningand Painting.

Thequalityassurance/ qualitycontroldocumentationshallinclude,butnotbelimitedtothefollowing:

•MaterialCertifications;

•ShopTest Reports;

•Allotherdocumentationrequiredbyapplicablecodesandstandards.

MinimumRequirementforInstruments&AutomationSystem Products.

Sr. No	InstrumentationSystem	Koramangala ISPS
1	FlowMeasuringSystem+Accessories+fittings	LS
2	LevelMeasuringSystem+Accessories+fittings	LS

3	PressureIndicatingTransmitters+Accessories+fittings	LS

4	PressureGauges+Accessories+fittings	LS
5	InstrumentationEarthing+Accessories+fittings	LS
6	Two&ThreePositionSelectorSwitches+fittings(IncludingElectrical Accessories Like:-P.B's, LED's, MCB's etc.)	LS
7	SurgeProtectionDevices+Accessories+fittings	LS
8	JunctionBoxes&FieldEnclosures+Accessories+fittings	LS
	InstrumentationCables/cabletrays	
9	Instrumentation(Analog)&ControlCablesandPowerCables, OFC, Trays, Glands & Lugs, cable conduits	LS
10	CableTraysandSupports	LS
	Automationsystem(PLC&SCADA/HMIsystem)forISPS	
11	ProgrammableLogicController(i.estandalone PLC)	LS
12	PowerSupplyModulesforPLCCPU	LS
13	CommunicationModules	LS
14	PLC&SCADA/ HMIsoftwares	1 set
15	InterposingRelayswithbase terminal	LS
16	SMPSforAutomationSystem	1 no.
17	ControlPanelswithInternalWiring	LS
18	SurgeProtectionDevices	LS
19	IndustrialTypeEthernet switches	LS
20	EngineeringWorkStation(EWS)PCforPLCProgramming	1
21	OperatorWorkStation(OWS)forSCADAsoftware	1
22	GPRSWirelessModules(Redundant)	1 set
23	UninterruptablePowerSupply	1

24	LaserMultijet Printer	1
25	2-TBSSDExternalDrives	2
26	2-TonSplitACsystemforControlRoom(SCADA/HMIRoom)	
27	**MandatorySparestobesuppliedforAutomationsystem(PLCbased HMIsystem) forISPS**	
i.	CPUfor PLC	1
ii.	CommunicationModule	1
iii.	Digitalinputmodule	1
iv.	Digitaloutputmodule	1
v.	Analoginputmodule	1
vi.	Analogoutputmodule	1
vii.	IndustrialTypeEthernet switch	1
viii.	PowersupplymoduleforPLCCPU	1
ix.	SMPSforAutomationSystem	1
x.	WirelessGPRScommunicationgateway	1

Note:Anyotheritemrequiredbutnotcoveredas above.

EndofPart13

PART14

INSPECTION,TESTINGANDCOMMISSIONINGREQUIREMENTS

Conte

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PART14

INSPECTION,TESTINGANDCOMMISSIONINGREQUIREMENTS

InspectionandTestingDuring Manufacture

General

(a) All inspection and testing shall be carried out in accordance with the Specification and in absence of Specification relevant Indian Standard or internationally approved equivalent standard. After award of contract, Contractor shall furnish a QA plan for approval by Employer.QAplanshallincludetestingforincomingsupplyofrawmaterialsand boughtout items, stage inspections and tests on finished products at manufacturer's works / appropriate testing station. QA plan shall clearly indicate tests which are intended to be witnessed by the Contractor alone and those by both contractor and Employer.

(b) **Inspectionandtestsscheduleshallbe as follows;**

1) Manufacturetests
2) Acceptanceinspection/Quantitychecking
3) Install/siteinspection
4) Siteacceptancetest
5) Testson Completion
6) ProcessWetTests (byRawSewage)
7) OperationTest(TestsAfterCompletion)
8) CompleteperformancetestsofISPSafter5-yearOperation(Beforeplanthandingover)
9) TestfurnishedasperISCode/manufacturerQAP

(c) TheContractorshallcarryoutatthe placeof manufacturetestsofthe Plant/Equipment atany part of the Works as per approved QAP.

(d) The Employer and/or duly authorised and designated representative(s) shall be entitled to attend the aforesaid inspection and/or tests.

(e) The Employer and his duly authorised representative shall have access to the Contractor's premises at all times to inspect and examine the material and workmanship of the mechanical andelectricalplantandequipmentduringitsmanufacturethere.IfpartoftheIS

PSand

equipment is being manufactured on other premises, the Contractor shall obtain permissionfor the Employer or his duly authorised representative, to inspect as if the ISPS andequipment was manufactured on the Contractors own premises. Testing (including testing for chemical analysis and physical properties) shall be carried out by the Contractor and certificates submitted to the Engineer who will have the right to witness or inspect the above mentionedinspection/testingat anystage desiredbyhim. Whereinspection ortestingisto be carried out at a subcontractor's works, a representative of the Contractor shall be present.

(f) Contractorshallprovidetestprocedure,pre-factorytestresults,andcalculationsheet,photoin advance and provide all of test result with necessary document including its data and photo to show Engineer that test is carried out in proper condition and its test results. Construction material shall be tested by contractor at the approved laboratory

(g) The procedure for the testing and inspection to be carried out during or following the manufacture of the materials to ensure the quality and workmanship of the materials and to further ensure that they conform to the Contract in whatever place they are specified shall be as described below.

(i) The Contractor shall give the Employer at least 21 clear days notice in writing of the date and the place at which any plant or equipment will be ready for inspection/testing as provided in the Contract. Prior to notice,contractor should submit pre factory test results as per clause 14.1.1(f)The Employer or his dulyauthorised representative shall thereupon at his discretion notify the Contractor of his intention either to release such part of the plant and equipment upon receipt of works tests certificates or of his intention to inspect.The employer shall then give notice in writing to the Contractor, and attend at the place so named the said plant and equipment which will be ready for inspection and/or testing. As and when any plant shall have passed the tests referred to in this section, the Engineer shall issue to the Contractor a notification to that effect after obtaining clearance from the consultants.

(ii) The Contractor shall forward to the Employer 6 duly certified copies of the test certificates along with characteristics performance curves/tables if any for all equipment obtaining dispatch clearance

from the consultants/Engineer

(iii) If the Engineer(s) fails to attend the inspection and/or test, or if it is agreed between the parties that the Engineer(s) shall not do so, then the Contractor may proceed with the inspection and/or test in the absence of the Engineer and provide the Employer with a certified report of the results thereof as per (ii) above.

(iv) If any materials or any part of the works fails to pass any inspection / test, the Contractor shall either rectify or replace such materials or part of the works and shall repeat the inspection and/or test upon giving a notice as per (i) above. Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection of that item.Any circuit previously tested, which may have been affected by the rectification work, shall be re- tested.

(v) Where the plant and equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the manufacturer's works.

(vi) Neitherthe execution of aninspection test of materialsor anypart of the works, nor the attendance by the Engineer (s), nor the issue of any test certificate pursuant to (iii) above shall relieve the Contractor from his responsibilities under the Contract.

(vii) The test equipment, meters, instruments etc., used for testing shall be calibrated at recognised test laboratories at regular intervals and valid certificates shall be made available to the Engineers at the time of testing.The calibrating instrument used as standards shall be traceable to National/International standards. Calibration certificates or test instruments shall be produced from a recognised/Laboratory for the Engineer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test.

(viii) Items of plant or control systems not covered bystandards shall betestedin accordance with the details and program agreed between the Engineer and Contractor's Representative. If such materials or works are found to be defective or not conforming to the Contract requirements, due to the fault of the Contractor or his sub-contractors the Contractor shall defray all the expenses of such inspection and/or test and of satisfactory reconstruction.

(ix) Testsshallalso be carried outsuchthatdueconsideration is giventotheSiteconditions under which the equipment is required to

function. The test certificates shall give all details of such tests.

(x) The Contractor shall establish and submit a detailed procedure for the inspection of materials or any part of the works to the Employer for approval within the date indicated in the Programme Details. The detailed procedure shall indicate or specify, without limitation, the following :

- Applicablecode,standard,andregulations.
- Fabricationsequenceflowchartindicatingtestsandinspectionpoints.
- Detailed tests and inspection method, indicating the measuring apparatus to be used, items to be measured, calculation formula, etc.
- Acceptancecriteria.
- Testreportformsandrequiredcodecertificatesanddatarecords.
- Methodofsampling,ifanysamplingtesttobe conducted.
- Contractor'sorEmployer'switnesspoints.

(xi) The Contractor shall not pack for shipment any part of the Plant until he has obtained from the Employer or his authorised representative his written approval to the releaseof such part for shipment after any tests required by the Contract have been completed to the Employer's satisfaction.

(xii) The following Inspection and Testing procedures shall be carried out for the equipment as per approved QAP.
Thedetailedprocedureshallindicateorspecify,withoutlimitation,thefollowing:

- RawMaterial
- Visual Inspection/Appearance.
- ChemicalandMechanicalpropertytests
- DimensionChecking
- Dynamicbalancingforallrotatingparts
- Stageinspection
- Hydrostatic/ Leaktestingforallpressureparts,PneumaticLeakTestwherever applicable
- Repairprocedure
- Operationcheck
- Procedure Qualification Record (PQR); Welding Procedure Qualification (WPQ) and Welders Qualification Report (WQR)
- MaterialTest
- Assembly/Connection
- Documentation

(η) The Contractor shall maintain proper identification of all materials used, along with reportsfor all internal / stage inspection work carried out, based on the specific job requirement and or based on the datasheets / drawings / specifications.

(ι) The expenses incurred during inspection shall include, but not be limited to all travelling, boarding, lodging and out-of- pocket expenses.

(1) The Contractor shall be responsible for all expenses incurred by the Engineer or person/s nominated by the Engineer in attending inspection and tests of Plant carried out during manufacture within India and abroad. Normally two or three persons from Employer side will witness the Inspection and testing along with the contractor's representative.

(2) Cost of inspection when material or any part of the facilities is not ready at the time specified by the Contractor for inspection or when re-inspection is necessitated by prior rejection shall also be borne by the Contractor.

(φ) Witnessed testing will normally be waived on standard types of equipment such as small motors made by approved manufacturers, individual standardised instruments, small mass produced components used in the manufacture of Plant items, small bore pipework and fittings, minorinstallationmaterialsandlowvoltage cable.In order toremove doubtthisshall not relieve the Contractor of his obligation under the Contract to ensure that all Plant is tested at the manufacturer's works prior to delivery to Site.

(κ) As a guide to the Contractor the Employer reserves the right to witness testing of the following but not limited to the following Plant items:

α)Electrical:

(1) Transformers
(2) 11kVMetalenclosedswitchboards&Switchgears.
(3) 415VMetalenclosedswitchgears(PCC)/ MCC
(4) 415VPowercapacitorandcontrolpanel
(5) DieselStandbyGeneratorwithAMFControlPanel
(6) Battery,batterychargerandDCDistributionBoard
(7) NonSegregatedBusDuct

(8) Power&controlcables

(9) LightingSystem

β) Mechanical:

(1) Submersiblepumpsincludingtheirmotors,Valveandpenstockactuators
(2) AlltypeofValves
(3) DI,MS,PSC,HDPE,uPVC&GIPipes
(4) Sluice&WeirGates
(5) Expansion/DismantlingJoints.
(6) ISPSMediumScreens
(7) EOT CranesandHoists
(8) Dewateringpumps
(9) HorizontalCentripetalPumps

χ) InstrumentationandControl:

(1) LevelMeasuringSystem
(2) Pressure Gauges
(3) PressureTransmitter
(4) FlowMeasuringSystem
(5) TemperatureMeasuringSystem
(6) InstrumentationandControlCables
(7) InstrumentControlPanel
(8) ProgrammableLogicController
(9) HMISystem
(10) UninterruptiblePowerSupplySystem
(11) WirelessGPRSgatewaytesting
(12) FAT&SATforcompleteICAsystem

(λ) Alldestructivelytestedsamplesshallbereplacedwithnew.

(μ) TheEmployerreservestherighttobepresentduring the testingand inspectionofallPlant items.

Materials,Plant,andEquipment

The Contractor shall place orders for the material and the equipment only after approval QAP by the Engineer. The Contractor shall submit the detailed technical and its drawings from the approved manufacturerandtheprocedureofsubmission,reviewandrevisionshallbeasspecifie dhereinbelow.

The Contractor shall inform the Employer about the likely dates of manufacturing, testing, and dispatching of any material and equipment to be incorporated into the Permanent Works. The ContractorshallnotifytheEmployerforinspectionandtesting,atleasttwenty-eight(28)dayspriorto packing and shipping and shall supply the manufacturer's test results and quality control certificates.

DispatchClearance

Allmechanical/electrical/ instrumentationequipmentshallbetestedattheirrespectivefactorywhich will be witnessed by tri parties (Contractor, BWSSB/Consultant inspecting team) in line with approvedQAPandEquipmentDatasheet.AlltheExpensestowardstotheinspections hallbeborne by the contractor only it should inclusive in the quoted price in the price schedule.

Thetestobservationsheets,materialtestscertificates(chemicalandmechanicaltesta tlaboratory)and joint inspection report shall be signed by the Contractor, BWSSB/Consultant officials after successfully completion of tests.

ContractorshallforwardalloriginalreportstoBWSSBandcopytoConsultantforverifi cationand issuances of Dispatch Clearance Certificates as per clause 14.1.1 g (ii). No Dispatch Clearance Certificate will be issued at the factory itself by the inspecting agency

FactoryAcceptanceTest(FAT)Document

Fifty six (56) days prior to commencement of inspection of each Plant item / equipment theContractorshallsupplyaFactoryAcceptanceTest(FAT)Documentforapproval.T hisshallcomprise four copies of the following:

- UnpricedcopyoftheContractorsorderforthePlantitem/equipment concerned:
- Detailsoftheinspectionandtestprocedurestobecarriedout.
- Pre-factorytestresultsanditsphotos.

TheFAT Planshallprovidecomprehensivedetailsoftheteststobecarriedout,thepurposeofea ch test, the equipment to be used incarryingout the test and the methods to be adopted incarryingout thetests.The FAT shall provide space within the documentationfor resultsoftheteststo beadded and for each test and for the

FAT as a whole to be signed off by the Contractor and the Engineer.

On completion ofthetests the Contractor shallprovidefourcopies of alltest certificates, curves etc. fortheinspectedPlantitem.Toremovedoubttestcertificatesshallbeprovidedforthe Plantitemas a whole plus certificates for the relevant component parts such as:

- Motors;
- , pumps
- Instruments;
- Gearboxes;
- Electricalswitchgear
- Integralcontrolandswitchgearpanels;
- Valvegear;
- Castings.
- Actuators
- Cranesand Hoists
- Screens
- Pumps

InspectionandTestingProgramme

TheContractorshallsubmittotheEngineernotlaterthan56dayspriortothecommencementofthe first inspection andtest during manufacturea programme detailingtheinspectiondates for all Plant. Those items of Plant that the Engineer has specifically identified for witness testing test shall be highlighted in the programme.

TheContractorshallkeeptheEngineerinformedofanychangestotheprogramme.

TheEngineershall not berequestedtoinspectanitemofPlantuntiltheContractorhassatisfied himself that the equipment meets all requirements of the Employer’s Requirements.

The Contractor shall inform the Engineer in writing at least 21 days in advance regarding readinessfor carrying out inspection of equipment/material etc. at manufacturer's works or at places of inspection. The programme for inspection shall be finalised by the Engineer after the receipt of the above case equipment/material etc. is found not to comply with the specification, dates for re- inspection shall be finalised and expenses incurred by the Employer for such visits shall also be recovered from the Contractor. Contractor's Representatives shall essentially be present during all inspections of Plant items. The following information shall be given in the inspection call letter mentioned above:

(α) Nameof manufacturer/supplier;

(β) Addressofplacewhereinspectionistobecarriedout;

(χ) Proposeddate/sandequipmenttobeinspected;

(δ) Name/sofcontactpersonnelatmanufacturer's/supplier/ sworkswiththeir telephone and fax numbers.

(ε) NameofContractor'sRepresentativewhowillbepresentduringt he inspection.

(ϕ) Confirmationthat internal testinghas been completed.Submissionof internal testing report for review before visiting the plant

The Contractor shall provide all the necessary instruments, test facility, water / electric power, test piece, samples, engineers/ workers, all cost and others to carry out the tests after assembly.All instruments used for such tests shall be calibrated and certified by and approved by an independent testing authority not more than one month prior to the tests in which they are used.Calibration certificates with expire date and name of authorization agency for instruments used for such testsshall be produced for the approval of the Engineer and if necessary, instruments shall be recalibrated before the commencement of the tests.

No material shall be delivered to the Site without Dispatch clearance certificate having been carried out or waived in writing by the Engineer.

If during or after testing, any item of plant fails to achieve its intended duty or otherwise proves defective, it shall be modified or altered as necessary and retested and re-inspected as required by the Engineer.

TestsatManufacturer'sPremises – MechanicalEquipment

SewagePumps

(α) All pumps shall be assembled completely in the shop to ensure correct fitting of all parts and shall be match-marked before shipment.

(b) All pumps shall undergo witness performance tests at the pump manufacturer’s Works. Testing shall be undertaken with the respective job motor for all the pumps being supplied under the

Contract.

(c) All tests such as Q/H curve, efficiency of pumps, power consumption, vibration and noise level shall be conducted, and NPSH tests one for each pumping station shall be undertaken to verify that the pumps meet the specified criteria.The pumps shall be run at constant flow capacity and speed.

(d) Pump casings shall be subject to hydrostatic pressure testing as an assembly at 150% of the pump shut-off head or 200% of the pump rated head whichever is higher.The hydrostaticpressureshall beheldfornotlessthan30minutesafterallleakshavebeen stopped between attachments.

(e) Impellerandpumprotatingassemblyshallbedynamicallybalancedaspe rISO1940/ Gr. 6.3 / VDI 2060.

(f) Standard running test shall be conducted as per BS 5316 Part 2 Class B / ISO 3555 at theratedspeedatmanufacturer'sworkstomeasurethecapacity,totalhe ad,efficiency and power.These tests shall form the basis for pump acceptance except for vibration and noise.The pump shall be tested over a range comprising shut off head to maximum flow.Minimum seven readings approximately equidistant shall be takenfor plotting the performance curve.

(g) Thefollowing formulashallbetaken forcomputingthe powerinput to thepump:

Powerinput to thePump in kW: $\frac{Q \times H \times 1.05}{367.2 \times \eta_p}$

Where, Q=Dischargein cum/hr
H=Total headin mwc
η_p=Efficiencyof pump

(h) If the vibration, noise level readings taken during performance test show higher than that permitted, vendor shall guarantee to show that the values shall be maintained at siteaftererection.Anycost ofrectification needed on thiscount shallbebornebythe Contractor.

(i) Stage inspection for pumps shall be carried out as per approved QAP/ The Contractor has to make all necessary arrangement for witnessing the same.

Motors

(a) RoutineTests

AllroutinetestsshallbecarriedoutonallmotorsasperthelatesteditionofIS325.

(b) AcceptanceTests

Fullloadtesttodetermineefficiency,powerfactorandslipshallbeconductedon allthe motors.

(c) Type tests

Thefollowingtypetestsshallbecarriedout ononemotorofeachratingabove18.5kW.

(1) Isolationresistancetest
(2) Temperaturerisetest
(3) Momentaryoverload test
(4) Vibrationmeasurementtest
(5) Noiselevel test
(6) Overspeed/overload test
(7) Startingcurrent,startingtorque,andpullouttorqueatreducedvoltage

ValvesandExpansion Joints

(a) During testing there shall be no visible evidence of structural damage to any of the valve component.

(b) Motorized valves shall be tested with their job actuator, with a differential head equivalent to their maximum workingpressure, to provethat the actuators arecapable of opening and closing the valves under maximum unbalanced head condition within the specified opening or closing period.

(c) Hydrostaticallytested shall beasperrelevantIS/BS standardforeach typeof valve.

(d) Thefollowingtest shall becarried outforsluicevalves, KnifeGatevalves:

(1) Seatleakage test.
(2) Bodyhydrostatictest.
(3) Valveoperation.
(4) DimensionalCheck.
(5) Visual Inspection.

(e) Thefollowingtest shallbecarried outforAir valves:

(1) Seatleakagetest.
(2) Bodyhydrostatictest.
(3) DimensionalCheck.
(4) Visual Inspection.

(f) Thefollowingtest shall becarried out fornon-return valves:

(1) Seatleakage test.
(2) Bodyhydrostatictest.
(3) Valveoperation
(4) DimensionalCheck.
(5) Visual Inspection.

(d) ThefollowingtestshallbecarriedoutforDismantling/ExpansionJoints:

(1) Leakagetest.
(2) Bodyhydrostatictest.
(3) Displacementrange.
(4) DimensionalCheck.
(5) Visual Inspection.

Pipe-work

Testing of pipes and fitting shall be carried out in accordance with relevant Indian Standard and internationallyapprovedstandard.Pipes,fittingsandexpansionbellowsshallbehydrostaticallytested for 1.5 times the rated pressure.

Thefollowingtestshall becarriedout forpipelines:

(1) Pressuretest
(2) Leakagetest
(3) LPtestforweldingpipeline
(4) Weldingbeatcheck
(5) DimensionalCheck
(6) Visual Inspection

Crane& Hoists

The cranes shall be completely assembled in the Contractor’s or subcontractor’s Works and shall be subjectedtothetestsasspecifiedinIS807/IS3177orrelevantinternationallyapproved standard.The Contractor shall provide the test weights.

Hoistsandliftingequipmentshallbeassembledandtestedattheplaceofmanufacturei naccordance with IS 3938.

Eachandeveryrotatingpart/assembly/sub-assemblyshallbedynamicallybalancedaspergradeG16 of ISO 1940/1 - 1986.

Sluice&WeirGates

(a) SeatClearanceCheck

Withthegatefullyclosed,theclearancebetweenseatingfaceswhenchecked withthefiller gauge, shall not exceed 0.1 mm.

(b) MovementTests

Each gate shall be shop operated Manually/Electrically three times from the fully open positiontothefullyclosedpositionandreturntofullyopen,under noflowconditionsto demonstrate that the assembly is workable.

(c) LeakageTests

With the gatein closed positiondesign pressure shall be applied for a period notlesser than 5 minutestotheunseatingsideofthesluicegateandtheleakageshallnotexceedt hemaximum leakage permissible as per IS 13349.

(d) HydrostaticTests

Finally a differential of one and a half times the design pressure shall be applied to the unseatingsideofthegate.Underthesetestsnopartshallshowanydeflectionof deformation.

MechanicalMediumBarScreens&J-typeManualScreens

(a) Allscreensshallbecheckedforoveralldimensions,assembly,andclearancebetweenthebars / space between a rake and bar surface / aperture size and its material as well as painting works. Moreover, motion of rake/drum and wiper/self cleaning arrangement shall also be tested at works.

(b) Conveyor shall be checked for dimensions and physical conditions, belt joint portion, travelling accuracy of belt, motors and its power consumption, performance of safety device.

(c) All the screen of each type shall be tested for efficiency and operation by employing screenings. For the screen having depth of channel more than 3 metres, testing with reduced depth is acceptable.

MiscellaneousPumpsets(DrainageandDomesticPumpsets)

Allthepumpsetsshallbetestedforperformanceasper IS 5120.

ReinforcedCementConcretePipes

Testing

(1) All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS: 458.

(2) Contractor shall provide laboratory test /analysis results of cement and aggregate component and cement vs. aggregate vs. water mixing ratio and concrete mixing time and mixing method.

(3) During manufacture, tests on concrete shall be carried out as per IS:456. Themanufacturer shall supply, when required to do so by the Engineer the results of compressive tests of concrete cubes andsplittensile tests of concrete cylinders made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the Engineer and such cylinders or cubes shall withstand the tests prescribed as per IS:458. Every pressure pipe shall be tested by the manufacturer for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.

(4) Thespecimen ofpipesforthe followingtestsshallbeselectedin accordance withrelevant clause of IS:458 and tests in accordance with the methods described in IS:3597.

(1) Hydrostatictest
(2) Threeedgebearing test
(3) Absorptiontest
(4) Dimensionandcolourof surface
(5) Damage

Samplingand Inspection

(1) In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this Employer’s Requirements shall be ascertained on the basis of tests on pipes selected from it.

(2) The number of pipes to be selected from the lot for testing shall be in accordance with Table 15 of IS:458.

(3) Pipesshall beselected at random. In order to ensurerandomness, all thepipes in the lot may be arranged in a serial order and starting from any pipe, everyr-thpipe be selected till the requisite number is obtained, r being the integral part ofN/nwhere N is the lot size and n is the sample

size.

(4) All pipes selected shall be inspected for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

(5) The number of pipes to be tested shall be in accordance with column 4 of Table 15 of IS:458. These pipes shall be selected from pipes that have satisfied the requirements mentioned in the above clause.

(6) A lot shall be considered as conforming to the requirements of IS:458 if the following conditions are satisfied.

(7) The number of defective pipes shall not be more than the permissible number given in column 3 of Table 15 of IS:458.

(8) All the pipes tested for various tests shall satisfy corresponding requirements of the tests.

(9) In case the number of pipes not satisfying requirements of any one or more tests, one or two further samples of same size shall be selected and tested for the test or tests in which the failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

(10) Alldestructivelytestedsamplesshallbereplacedtonew.

SteelCylindersPipesandSpecials

Testing

a) WeldingbeatcheckRemoveallscaleontheweldingpointsandweldingbeata ndits thickness shall be checked by the Engineer.

b) PenetrationTest
A suitable penetrating liquid (kerosene oil/Dye) is applied to the surface of the portion underexaminationandispermittedtoremainthereforsufficienttimetoallo

wtheliquid to penetrate into any defects open at the surface. After the penetrating time, the excess

penetrant, which remains on the surface is removed. Then a light coloured powder absorbentcalledadeveloperisappliedtothesurface.Thisdeveloperactsas ablotterand draws out a portion of the penetrant which had previously seeped into the surface openings. As the penetrant is drawn out it diffuses into the coating of the developer, forming indication of the surface discontinuities or flaws.

c) Each steel cylinder shall be subjected before lining/coating to a hydrostatic test under a water pressure equivalent to the test pressure in accordance with Clause 10 of IS:1916 and relevant provisions of IS:3597, provided that the whole of the area of the calculated reinforcement is used in the steel cylinder. In the case of pipes where a part of the principal reinforcement is provided in the cage, the steel cylinder shall be subjected to proportionately less hydrostatic test pressure.

d) Manufacturer's standard specials shall be hydrostatically tested before lining/coating. Where feasible, other specials shall be hydrostatically tested (before lining/coating) at factory. However, when this is not practicable, at the discretion of the Engineer, the unlined specials shall be tested by penetration test as per IS:3658 or other approved means.

e) ThecontractorhastosubmitQA/QCandmethodologyforweldingworks

f) Approvalofweldingrods

g) WeldersqualificationTest

CastIron/DuctileIronPipes

MechanicalTests

Mechanical chemical tests shall be carried out during manufacture of pipes and fittings as specifiedinrelevantIScodes.Theresultssoobtainedshallbeconsideredtorepr esentallthe pipes and fittings of different sizes manufactured during that period and the same shall be submitted to the Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and

fittings shall be as per relevant IS codes.

Brinellhardness Test

ForcheckingtheBrinellhardness,thetest shall becarriedout onthetestringorbarscutfrom the pipes used for the ring test and tensile test in accordance with IS 1500.

Retests

Ifanytestpiecerepresentingalotfailsinthefirstinstance,twoadditionaltestssh allbemade on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

Hydrostatictest

Forhydrostatictestatworks, thepipesand fittingsshallbekeptundertestpressureasspecifiedin relevant IScodestheymaybestruck moderately with a 700 g hammer. They shall withstand the pressure test without showing any leakage, sweating or otherdefect of any kind. The hydrostatic test shall be conducted before coating the pipes and fittings.

Mechanical equipment

Allmechanicalequipmentshallbetestedatsiteasfollowingitemsin below,

(a) The test will be verified any damage/missing part, No. of equipment to be installed, material, location as specified in drawing, levelling, centreline, solid installation and condition of installation to be fit in levelling of pipeline and valves.

(b) Testing run will be conducted for verifying rotation direction, vibration, noise, and stability and any leakage, if possible.

(c) The test will be verified to check maintenance space and ease of equipment maintenancework.

(d) The testing shall be performed in full compliance with the latest version of the applicable standard testing protocol. These tests shall be witnessed by Engineer per procedures set forth for witnessing elsewhere in this document.

Testsatsite

(a)In addition to the progressive supervision and inspection by Engineer, the Contractor shall offer for inspection to Engineer, the completely erected plant/part of Plant on which tests are to be carried out. After such inspection, each equipment/sub-system shall be tested by the Contractor in accordance with the applicable standards in the presence of Engineer.Such tests shall include but not be limited to the tests specified in following clauses.

The Contractor shall possess during the entire working period the Electrical Contractor's licence of appropriate class from the concerned statutory authorities governing the area of work place. The Contractor shall fully comply with the relevant statutory rules and regulations. On completion of the installation or at intermediate stages, if required by the statutory authorities, the Contractor shall arrangeforinspectionandobtaintheapprovalfromtheconcernedstatutoryauthorities.Ifanyfeesare to be paid to statutory authorities for testing, inspection and calibration these shall be paid by the Contractor and shall be included in his erection and commissioning charges.

Pumps,pipingandvalves

(a) The erected pipe work shall be subjected to a hydraulic test at 1.5 times the maximum pressure or twice the working pressure whichever is higher to test the soundness of the joints.Provision of the necessary pumps, gauges, blank flanges, tappings etc. for carrying out these tests shall be included in the Contract. All gas piping shall be air tested to twice normal working pressure.

(b) Leakage tests shall be carried out on all erected pipework, pumps and valves immediately after erection and where possible before being built in.

(c) Operatingtestsshallbeconductedon valves.

(d) The pump set shall be tested for satisfactory operation. The vibration and

noise level shall be checked to be within the specified limits.

Motors

Conditionofwindinginsulation
betestedandinsulationvaluesshallberestoredtorequiredlevelby suitable heating arrangements locally.

Cranes&Hoist

Thecraneandliftingtackleshall
betestedto125%ofthesafeworkingload.TheContractorshall arrange the test load. The contractor shall also arrange for the appropriate certificates from the concerned authorities before regular use of the cranes and other lifting equipment.

Screens

Aftererection,allscreensscreenshallbetestedforsmoothoperationandcapabilitytoh andletypical wastewater solids including stringy materials.Clearance between the dead plate and tines shall be checked as applicable.

Sluice&Weir Gates

(a) LeakagetestshallbeperformedbytheContractorafterinstallationofallGates.

(b) Underthedesignseatingheadandunseatingheadtheleakageshallnotex ceedthelimit specified in IS:13349, for shop testing.

ReinforcedCementConcretePipes

(a) After laying and jointing of RCC pipes is completed the pipe line shall be washing out with sufficient waterandbe testedat worksiteaspertheEmployer’sRequirementsandasdirected by the Engineer. All equipment for testing at work site shall be supplied and erected by contractor. Water for testing of pipes shall be arranged by him. Damage during testing shallbe contractor's responsibility and shall be rectified by him to full satisfaction of the Engineer. Water used for the test shall be removed from pipes and not released to the excavatedtrenches.

(b) After the joints have thoroughly set and have been checked by the

Engineer and before back filling the trenches, the entire section of the sewer or stormwater drain shall be proved by the

contractor to be water tight by filling in pipes with water to the level of 1.50m above the topof the highest pipe in the stretch and heading the water up for a period of one hour.

(c) Theapparatus used for thepurpose oftestingshall beapproved bythe Engineer.Contractor if required by the Engineer shall dewater the excavated pit and keep it dry during the period of testing. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For the approval of this test the average quantity added should not exceed 1 litre/ hour/100 linear metres / 10mm of nominal internal diameter. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

(d) In case of pressure pipeline, the completed stretch of pipeline shall be tested for site test pressure. The site test pressure should not be less than the maximum operating pressure plus the calculated surge pressure, but in no case should it exceed the hydrostatic test pressure as specified in IS: 458.

SteelCylinderPipesandSpecials

(a) After laying and jointing of steel cylinder pipes and specials with concrete / other lining and coating is completed the pipeline shall be washing out with sufficient water and be tested at work site as per the following Employer’s Requirements and as directed by the Engineer. All equipment for testing at work site shall be supplied and erected by Contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be Contractor’s responsibility and shall be rectified by him to the full satisfaction of the Engineer.Water used for test shall be removed from pipes and not released to the excavated trenches.

(b) Each section of the pipe line shall be slowly filled with clean water and all air shall be expelled from the pipeline. The pressure in the pipeline should then be raised and maintained by means of pump to the test pressure.The test pressure should not be less than 1 1/2 times the working pressure at the lowest point or the static head pressure, whichever is higher. Under the test pressure no leak or sweating shall be visible at the welded joints. The duration of test shall be not less than 24

hours. The exposed joints shall be carefully examined and all such joints showing visible leaks shall be re-welded. Any cracked or defective pipes and specials in consequences of this pressure test shall be removed and replaced by soundmaterial by Contractor and the test shall be repeated to the satisfaction of the Engineer.

(c) Hydrostatic shop test for pipes and fittings shall be as per code/standard requirement.After erection at site, complete pipes and fittings shall be hydrostaticallytested for a pressure of 1.5 times operating pressure.

(d) Where directed by the Engineer welded joints on pipes larger than 675 mm diameter shall be subject to a nitrogen gas test after welding.

(e) Atappedhole(approximately6mmdiameter)shall bemade inthesocketendofeachpipeby the Contractor and shall be fitted with a suitable non-return valve. Nitrogen, at 400 kPa pressure, shall then be pumped into the annular space between the spigot and socket and the pump disconnected.

(f) Ifnodropinpressureoccursover theensuingperiodof30minutesthetest shall bedeemedto be successful. If the test pressure cannot be maintained for 30 minutes all defects in the weld shall be cut back and re-welded and the test reapplied until successful. The cost of initial and subsequent testing of defective welds shall be at the Contractor's own expense.

(g) The Contractor shall provide all items necessary for the nitrogen tests including compressor, valves, gauges and tubing.

CastIron,DuctileIronPipesandFittings

(a) After the pipes and fittings are laid, jointed and the trench partially backfilled except at the joints the stretch of pipe line as directed by Engineer shall be subjected to pressure test and leakage test after washing the pipe line out with sufficient water.
Where any section of the pipeline is provided with concrete thrust blocks or anchorages, the pressuretestshallnotbemadeuntilatleastfivedayshaveelapsedaftertheconcr etewascast. If rapid hardening cement has been used in these blocks or anchorages, the tests shall not be made until at least two days have elapsed.

(b) Each section of the pipe line shall be slowly filled with water and all air shall be expelledfrom the pipe by tapping at points of highest elevation before the test is made and plugs insertedafterthetestshavebeencompleted.Thespecifiedtestpressurebasedo ntheelevation of the lowest point of the line or section under test and

corrected to the elevation of the test gauge shall be applied by means of a pump connectedto the pipe as directed by the Engineer.

(c) The duration of test shall not be less than 5 minutes. The exposed joints hall be carefully examined and all such joints showing visible leaks shall be recaulked until water tight. Any cracked or defective pipes and fittings in consequence of this pressure test shall be removed and replaced by sound material by Contractor at no extra cost to the Engineer and the testshall be repeated to the satisfaction of the Engineer.

(d) After the satisfactory completion of pressure test, the section of pipe line shall be subjected to leakage test. The duration of test shall be 2 hours. No pipe installationshall be accepted until the leakage is less than the number ofcm^3/h as determined by the formula:

$$q_L = \frac{ND\sqrt{P}}{3.3}$$

Where,

q_L = Theallowableleakageincm^3/hr

N = Numberofjointsinthelengthofthe pipeline

D = Diameterinmm,and

P = TheaveragetestpressureduringtheleakagetestinKg/cm^2

Should any test of pipe laid indicate leakage greater than that specified above, the defective jointsshall berepairedbyContractoratnoextracosttotheEngineeruntiltheleakageiswithinthespecified allowance.

(e) Necessary equipment and water used for testing shall be arranged by Contractor at his own cost. Damage during testing shall be Contractor's responsibility and shall be rectified by himat noextracosttotheEngineer.Waterusedfortestingshall beremovedfromthepipeandnot released in the excavated trenches.

(f) After the tests mentioned above are completed to the satisfaction of the Engineer, the backfillingoftrenchesshallbedoneaspertheEmployer’sRequirementsspecifi

edelsewhere.

Manufacturer'sWorksAcceptanceTestsonElectrical Equipment

The following equipment / items shall be subjected to inspection, routine /acceptance tests asperlatesteditionofrelevantIndian/Internationalstandardsinthepresence ofEmployer/ his Engineer

(aa)Transformers
(bb)11kVMetalenclosedswitchboards&Switc
hgears. (cc) 415 V metal enclosed
switchgears (PCC) /MCC (dd) 415 V Power
capacitor and control panel
(ee)
DieselStandbyGeneratorwithAMFControlPa
nel
(ff)Battery,batterychargerandDCDistributio
nBoard (gg) Non Segregated Bus Duct
(hh)Power&control cables
(ii)Cablecarriersyst
em (jj)Lighting
system
(kk)Earthingandlightningprotectionsystems

Copies of test Certificates for the type tests and Special tests not later than 5 years conducted as per relevant Indian / International Standards for all the equipment /items of above shall be furnished for the perusal of Employer / his Engineer. If type tests and special tests have not been conductedonanyoftheseitems,thesameshallbecarriedoutinthepresenceofowne r/Engineer at no extra cost.

Manufacturer'sWorksAcceptanceTestsonInstrumentation,PLC,HMIand Associated Equipment

A. Instrumentation:

Inspection,TestingandSettingto Work:

General

Eachitemofplantshallbesubjectedtothemanufacturer’sowntestswhichshallbe certified.

Eachitemofplantanditsinstallationshallbe subjecttoinspectionandtestingattheplaceof manufacture.

TheContractorshallberesponsibleforttheprovisionofallnecessarytestequipment.TheContractor shall demonstrate to the Engineer, the correct operation of any item of plant and the Engineer may witness any test. Tests which, in the opinion of the Engineer, were failed or not performed correctly shall be repeated.

CalibrationtestsshallbecarriedoutatManufacturer’sWorksforfieldinstrumentsandalsothesame Calibration tests should be conducted on site after installation and the same should be witnessed by the Engineer.

BeforeanytestismadetheContractorshallsubmittotheEngineerafulllistoftestequipment&test procedures (method statements) to be used. Each item of test equipment shall have a standard of accuracy better than that stated by the manufacturer of the item to be tested. The Contractor shall provide evidence of the condition and performance of any item of test equipment, in the form of test certificates issued by an appropriate authority independent of the Contractor and manufacturer, or as otherwise directed by the Engineer. Test equipment shall be checked frequently during the period of the tests.

TheContractor’sstaffresponsibleforsupervisingandcarryingouttestsshallbefullyconversantwith the various items of equipment of other manufacturers and if necessary the Contractor shall arrange for his personnel to attend suitable training courses on his own expense.

Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of theEngineerbeforeproceedingwithfurtherinspectionortestingofthatitem.Anycircuitpreviously tested, which may have been affected by the rectification work, shall be re-tested.

PreliminaryInspectionandTestingatthePlaceofManufacture

Field-mountedinstruments

After the successful completion of the manufacturer's own inspection and testing of instruments supplied under the Contract, similar tests shall be carried out in the presence of the Engineer and the Contractor. Such tests shall include a demonstration that an increase or decrease of the measured value at several points over the full range of the instrument produces a corresponding increase or decreaseintheinstrumentoutputsignal.Thesetestsshallincludechecksonthespecifiedaccuracyof the instrument at all points.

Instrumentpanels,enclosuresandmountingboards

Themanufacturershallnotpresentinstrumentpanels,enclosuresandmountingboards(assemblies) for inspection and testing until the manufacturer's own tests and inspection has been completed. A preliminary inspection and test of these assemblies may then be witnessed by the Engineer. The Contractor shall give not less than 7 days' Prior notice in writing that he has completed.

Histestsandinspectionandisreadyforthewitnessedtestsandinspection.Wherethisnoticeperiodis different in the Conditions of Contract this shall take precedent.

Thewitnessedinspectionandtestingshallincludethefollowing:

a. A visual inspection of the panel assembly to show that the design, construction and finish are satisfactory and in accordance with the Specification;
b. Acheckthatequipmentissecurelymounted,accessibleforremovalorcalibrationwithout damage to or undue disturbance of other components, wiring or piping;
c. Thatallengravingandlabelsarecorrectlypositioned,fixedanddesignatedinaccordance with the Specification;
d. Panelpower-distributioncircuitshavethecorrectbreaker/

fuseratingcoordinationand designation;

e. Power-isolationfacilitiesmeettheSpecification;

f. The main incoming supply voltage, frequency and/or pneumatic supply pressure is within the required limits, these being checked at the beginning and end of the test and the results recorded on test certificates;

g. The output of all power supply units again at the beginning and end of the testing with results being recorded;

h. The power supply voltage or air pressure of all component instruments of the assembly(s), these voltages/pressures being recorded on the test certificate;

i. The insulation resistance of all circuits except sensitive electronic equipment which is liableto damage by application of the test voltage, such circuits being disconnected before making the insulation resistance tests and these tests being carried out in accordance with IEE Wiring Regulations;

j. Thatthecleanearthbarisisolatedfrommainframeofthe panel.

Internallightingandanti-condensationheatersandassociatedthermostats,isolators,limitswitches and wiring shall be checked for compliance with the Specification.

Sparecapacitywithinthepanel(s)shallbecheckedtoseethatitcomplieswiththeSpecification.This shall include future equipment space, spare terminals, space in wiring trunkings and provision for additional cable entry.

FunctionalTestingatthePlaceofManufacture General requirements

OncethepreliminaryinspectionandtestingiscompletetothesatisfactionoftheEngineer,functional testingshallcommence.Thepurposeofthefunctionaltestsaretodemonstratethatinstrument panels enclosures and mounting boards (assemblies) conform with requirements of the Specification.

Notlessthan30daysbeforethecommencementoffunctionaltests,theContractorshallsubmitto the Engineer,for approval, twocopies of comprehensive test procedural documents detailingeach test to be carried out. The document shall include results forms on which the results of each test will be entered. The forms shall include spaces for numerical values, where necessary, and witness

signatures.

Allapplicabledrawingsanddatashallbeprovidedattheplaceofinspectionbythe Contractor.

TheContractorshallprovidealltestinstrumentsandequipmentnecessarytotestthea
ssembliesin their entirety.

Thefollowingisatypicallistoftheequipmentrequired:

•Switchboxes;

•Indicatorlightboxes;

•Analoguesignalsources;

•Dummyloads;

•Meters;

•Simulators;

•Desk-topcomputers;

•ProgrammersforHMIoroutstations;

•Insulationtestequipment

B. ProgrammableLogicController(PLC)andHMI

TheContractorshallcarryoutspecifiedtestsasfollowsinadditiontoanytestsstatedor
impliedby the foregoing sections of this clause.

The tests shall be carried out on the fully assembled control panel containing the PLC and associated equipmentinordertodemonstratecorrectfunctionaloperationofthehardwareandso
ftwaresystems.

FactoryAcceptanceTest (FAT)

TheContractorshallconductafullprogrammeoftestsofthePLC&HMIsystemattheCo
ntractor’s testing facility in the presence of the Engineer to verify that all features of the system have been provided,areoperatingcorrectlyandareinfullcompliancewiththeSpecification.FAT

shallinclude

PLCbasedcontrolsystemwithpanelmountedHMIforISPSwithwirelesscommunicationsystemfor the all of the above. Unless otherwise specified or agreed by the Engineer, the entire PLC &HMI system shall be assembled and tested together as an integrated system, including all master station equipment, all operators' consoles, all outstations and telemetry equipment all instrumentation panels and uninterruptible power supplies included in this Specification. The scheduled date for the factory acceptance test shall be as agreed by the Contractor and the Engineer at least four weeks before the test.FAT shall be conducted with a hardwired simulation panel connected to the PLC based HMI system. Contractorshallnote theimportance oftherequirement. Nosoftware based simulationtesting shall be accepted or allowed.

Not less than one month before the scheduled factory acceptance test, the Contractor shall submit to theEngineerforapprovaltwocopiesofacomprehensivemanualdetailingeachtesttobeconducted. The manual shall include a results form on which the results of each test will be entered, including spaces for numerical values where appropriate and witness signatures.

Not less than 7 days before the scheduled factory acceptance test, the Contractor shall give written notificationtotheEngineerthatacompletedry-runofthefactoryacceptancetesthasbeenperformed successfully and that, in the opinion of the Contractor, the system exhibits stable operation and is ready for the formal factory acceptance test.

The factory acceptance test will be considered successfully completed only when the system has successfully passed all factory tests. The system shall not be delivered to Site until the successful completionofthefactoryacceptancetestiscertifiedbytheEngineerorunless otherwiseapprovedby theEngineer.Delayinthedeliveryofthesystemduetofailureofthefactoryacceptancetestshallnot constitute an unavoidable delay. If the system fails the factory acceptance test, the test shall be extended or rescheduled at the discretion of the Engineer.

All hardwaretobeusedinthetestingofthesystemshall havepassedanagreedpreliminaryhardware performance test to ensure known hardware operability before software testing begins.

After successful completion of thefactoryacceptancetest, nosoftware changes shall be made tothe system without written authorisation by the Engineer. Any changes to the system which effect the system software documentation, such as input scale modifications or changes to the control logic, shall beenteredintothesystemdocumentationbeforedeliveryofthesystemtoSite.All instruments under IC&A scope has to be tested 100%.

FactoryAcceptanceTestProcedur

es General

Thescopeofthetestsshallincludetheprovingofeveryaspectofhardwareandsoftwar eoperation and functions as detailed below.

Hardware tests

(a) Verifythecorrectinventoryofhardwareincludingcablesandprintedcircuit boards;

(b) Demonstratethatallspare-memory,disk-capacityandsystem-expansionrequirementshavebeen met;

(c)Demonstrateallhardwareandsoftwarediagnostics;

(d) Verifyallpowersupplyvoltagesarewithin tolerance;

(e) Verifyproperearthconnectionsandisolationofinstrumentationearthforallequipment;

(f) DemonstrateoperationoftestsimulationandindicationequipmentanditsSuitabil ityforadequate functional testing of all system functions.

Softwaretests

(a) Demonstratetheeditingofallsystemparametersincludingset-points,timersandthelike;

(b) Demonstratesystemconfigurationcapabilitiesincludingtheadditionand deletionofinputand output points, outstations, and all data base parameters;

(c)Demonstratetheaddition,deletionandmodificationofmimicdisplaysandreportformats;

Functionaltests

Thefunctionaltestsshall verifyproperoperationofeveryspecifiedsystemfunctionasanintegrated system. These tests shall be conducted in conjunction with functional tests of instrumentation and controlpanelsasspecifiedelsewhere.Allfailures ordiscrepanciesfoundshallbedocumentedinthe test manual.

Following a failure of any functional test, should software or hardware modifications be required it shall bethedecision of theEngineer whetherthefactoryacceptancetest isto continue, re-start or be aborted. If testing is allowed to continue, any changes which are required shall be described in a systemmodificationdocument,signedbybothContractorandEngineerandbeincorporatedintothe final factory acceptance test documentation. The failed test shall be re-conducted and the Engineer may require the retest of functions which may be affected by the modification.

Thefunctionaltestsshallinclude,asaminimum,the following:

(a) Demonstrationthatthesystemmeetstherequirements oftheSpecificationforresponsetimeand speed of screen update;

(b) Verification of the accuracy of all analogue input points in the system. The procedure shallincludeapplyingtheappropriatesignaltoeachanalogueinput at aminimumofthreepointswithinthe range of the input, checking for expected numerical results, and verifying appropriate update ofrelated mimic displays. Proper sensing and action by the system to high and low out-of-range inputs shall also be verified;

(c)Verificationoftheproperlogicsense,pulseaccumulationandratecomputationwhereappropriate, of all digital inputs and verifying appropriate update of related mimic displays;

(e) Verification of all control and sequencing operations and proper operation of all digital and analogueoutputs.Theprocedureshallincludesimulationofallrelatedprocessvariablesforboth

normalandabnormalconditions,includinginstrumentandcomponentfailure,andd emonstrationof fail-safe response of the system. System outputs shall be indicated with appropriate lamps and indicators;

(f) Simulationofoutstationcommunicationserrorsandfailuresanddemonstrationo ferrordetection and handling, failure detection and handling, and appropriatechanges to controlactions as designed and specified;

(g) Verificationoffaultdetectionanddiagnosticsbyinducingasufficientvariety offaultconditions in the system to ensure that detection processes and fail-safe operation are adequately tested;

(h) Demonstrationofproperoperationofallmimicdisplays,helppages,reports, operatorprocedures and historical data accumulation;

(j) Demonstrationofproperoperationofalloutstationsfollowingasimulatedmaster stationcentral processor failure;

(k) Demonstration of proper operation of all equipment during both a system wide or isolated power failure, and following power restoration. The procedure shall include the demonstration of battery backupofbothmasterstationandoutstationforthefulllengthoftimespecified,andpro peroperation of power fail, low voltage warning and all associated alarms.

Reliabilitytest

Aftersuccessful completionofthefunctionaltestsa48-hourcontinuousrunofthesystemshall be performed.Thetestshallbepassedifnosystemfunctionis lostornohardwareorsoftwarefailure occurs. Hardware failure is defined for

this test as the loss of a major component such as the

computer,anoutstation,atouchscreendisplayunitoraperipheraldevice.Non-repetitivemechanical failures of loggers, push-buttons and the like are excluded.

Duringthistest,thesystemshallbeexercisedwithsimulatedinputsandconditionsina mannerwhich approximates the on-site operational environment. Unstructured testing by the Engineer shall be included during this test. Upon any system failure during this period, it shall be the decision of the Engineer whether the reliability test is to continue or be aborted. If testing is allowed to continue any changes to the system which are required shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final factory acceptance test documentation.

Factoryacceptancetestdocumentation

Asaminimum,thefollowinginformationshallbeincludedinthefactoryAcceptancetes tmanualfor each test:

•Testidentificationnumber;

•Testnameand description;

•Listofallequipmenttobetestedincludinganyspecialtestequipment required;

•Descriptionofthetestprocedurebrokendownintological steps;

•Descriptionoftheexpectedsystemresponseverifyingthecompletionofeachlogicalstep;

•Spaceforrecordingtheresultsofthetestandthetimeanddateofthetest;

•SpaceforsignaturesoftheContractorandtheEngineer.

In addition, the Contractor shall provide a method for recording and tracing all problems,
discrepancies,queriesandsuggestionsregardingthesystemandsoftware,andforfor malisedcontrol of any modifications to the system.

Pre-commissioningtests

The Contractor shall perform pre-commissioning, or preliminary, testing of the HMI system in accordancewiththatspecifiedforinstrumentation.Thepurposeofpre-commissioningtestsisto confirm readiness of the system for commissioning.

Thescopeofpre-commissioningtestsshallbegenerallyasspecifiedforfactoryacceptancetestsbut real field inputs and final control elements shall be used wherever practical to provide inputs to the system and to confirm proper outputs.

Wherethisisimpractical,simulationsignalsshallbeinjectedasnearaspossibletotheir ultimate sources so as to include in the tests as much of the cabling system as possible.

Each process system shall be set to work under manual control and the system tested to confirm properoperation.Afterproperoperationofmanualcontrolmodehastobeverified,tes tsofautomatic controls of each process system shall be conducted wherever practical.

Commissioning

SiteAcceptanceTests(SAT)

TheContractorshallsubmit allrelevant draft operatingmanualsforthePLC&HMISystemtothe Engineer for approval prior to

commissioning tests.

Anyfaultsorfailuresofthesystemdetectedduringthepreviousteststsshallbenotedandcorrectedto the satisfaction of the Engineer before commissioning is allowed to commence.

As part of commissioning, the PLC & HMI system shall be tested for availability for a continuous periodof60days.Duringthisperiod,thesystemwillperformthenormalfunctionsaccordingtothe procedures described in the SAT documentation approved by the Engineer.

Thesystemshall havepassedtheSATifall majorcomponentshavebeenfreefromfault orfailure and exhibit full error-free functionalityfor 100% of the total duration of the test,unless otherwise agreed by the Engineer. Major components include all master station equipment, outstations, communicationsfacilitiesandinstrumentpanelcomponents,excludingpush-buttons,switchesand lamps and any equipment not supplied by the Contractor.

During SAT, no modifications to the system shall be made by the Contractor without the written approval of the Engineer. Erroneous functioning which requires software modifications or re- configuration to correct, other than set-point or parameter changes, shall constitute a failure of the availabilitytest.Anychanges tothesystemwhich arerequiredand approved shallbe describedin a system-modification document, signed by both Contractor and Engineer and the document shall be incorporatedintothefinaltestdocumentation.Thetestshallberestartedaftercorrectionshavebeen made.

Manufacturer'sWorksAcceptanceTestsonUninterruptiblePowerSupplies

TheContractorshallcarryoutfurtherspecifiedtestsasfollowsinadditiontoanytestsstatedor implied by the foregoing sections of this clause.

Thetestsshallbecarriedoutonthefullyassembledunitutilisingthebatteriesthatareto besupplied with the unit.

TheContractorshalldemonstratethefollowing:

(1) Change-overfromfullloadwithmainspresenttofullloadonbatterysupply
(2) Carryoutadischargetestonthesystematfullload andforthespecifiedduty bridging time period.
(3) Carryoutrechargetestafteroperationforthespecifieddutybridgingtimeatfullload.The UPS shall supply the full load during the recharge cycle.

InspectionatSite

DuringerectionofthePlanttheEngineerwillinspecttheinstallationfromtimetotime inthe presence of the Contractor's Supervisor to establish conformity with the requirements of the Specification. Any deviations found shall be corrected as instructed by the Engineer.

PlantprotectiononSite

Factory finished plant shall be adequately protected both before and during installation againstdamage to finished surfaces, fitted components, and the ingress of dust.It may be necessary for structural finishing operations to be carried out in the vicinity of installed plant before it is taken over and the Contractor shall take this into consideration in complying with the requirement of this clause.

Erectionstaff

The Contractor shall provide at least two approved senior English speaking working erectors to supervise the erection of all Plant in the Contract and in each case to act as the Contractor's Representative as set out in Clause 13 of the general conditions of contract.

In the case of a foreign firm based overseas the Contractor's Representative shall be thoroughly conversant with the manufacturer's Plant and equipment, and its erection and shall be an expatriate.

The Contractor shall also provide sufficient erectors skilled in electrical, mechanical and instrument engineering, with such skilled, semi-skilled and unskilled labor as are necessary to ensure completion of the various sections of the Contract in the time required.The Contractor shall not remove any supervisory staff or labor from the site without the prior approval of the Engineer.

The Engineer will give the Contractor at least one month's notice in writing of

the date on which the erection staff will berequired on site, and the Contractor shall confirmthe date ofarrivalin writingto theEngineer.TheContractorshallmakeallthenecessaryarrangementstoensurethat sufficientplant has been or is about to be delivered to site, so that there shall be no delay to the start of erection.

It shall be the responsibility of the contractor to obtain necessary License / Authorization n/Permit for work from the Licensing Boards of the Locality/State where the work is to be carried out.The persons deputed by the Contractor’s firm should also hold valid permits issued or recognized by the Licensing Board of the Locality/State where the work is to be carried out.

ErectionandBuilding-in

Theinstallation work shallcomply with the latest applicable Standards, Regulations, Electricity Rules and Safety Codes of the locality where the installation is to be carried out. Nothing in thisspecification shall be construed to relieve the Contractor of this responsibility.

It will be the Contractor’s responsibility to obtain approval/clearance from local statutory authorities including Electrical Inspector, wherever applicable for conducting of any work or for installation carried out which comes under the purview of such authorities.

The Contractor shall carry out the complete erection of all plant, including the provision of all necessary skilled and unskilled labor, material, transportation, supplies, power and fuel, Contractor's Equipment and appurtenances necessary, for the complete and satisfactory erection of the Plant.

The Contractor shall have a separate cleaning gang to clean all equipment under erection and as well astheworkareaandtheprojectsiteatregularintervalstothesatisfactionofthe employer.Incasethe cleaning is not up to the employer’s satisfaction, he will have the right to carry out the cleaning operations and any expenditure incurred by the employer in this regard will be to the Contractor’s account.

Erectors

The Contractor's employees shall include skilled erection staff in sufficient number, who shall arrive on the site on or before the respective dates set out in the approved work programmed and prior to delivery of any item of Plant to the Site.The Engineer will not entertain any claim bythe Contractor in respect of delayed erection due to a delay in the delivery of any items of Plantto the site.

Contractor'sEquipment,materialsandappurtenances

The Contractor shall have available on the Site sufficient suitable equipment and machinery, as well as all other materials and appurtenances required by

him, of ample capacity to ensure the proper erection of Plant and to handle any emergencies such as may normally be expected in work of this character.

The Contractor shall be responsible if any installation materials are lost or damaged during installation. All damages and thefts of equipment/component parts, after takeover by the Contractor, till the installation is taken over by Employer shall be made good by the Contractorto the satisfaction of Engineer.

Workmanship

Plant shall be erected in a neat and workmanlike manner on the foundation and at the locations and elevations shown on the approved drawings and other Engineering documents.Unless otherwise directed by the Engineer the Contractor shall adhere strictly to the aforesaid drawings and no departures there from will be permitted.

All plant shall be correctly aligned, leveled and adjusted for satisfactory operation and shall be installed so that the proper and satisfactory connection can be made readily between the various units and pipe work and equipment installed under the Contract.The mounting arrangements for pumpsets and blowers shall be such that the alignment offset between motors and the driven equipment shall be well within 0.1 mm.

Building-in

Erection of Plant shall be phased in such a manner so as not to obstruct the work being done by other contractors. Before commencing any erection work, the Contractor shall check the dimensions of structures where the various items of plant are to be installed, and shall bring any deviationsfromtherequiredpositions,linedordimensionstothenoticeoftheEngineerandshall take such measures as are necessary for their correction.

The Contractor shall take particular care for the correct positioning and alignment of all puddle pipes which are required through concrete structures prior to, and during the pouring of concrete.

The Contractor shall pin and plug in the holes prepared, all small clips, plugs, screws, nails, sleeves,inserts,etc., required for fixingelectric wiresand conduits,small pipe workand all other apparatus.

The Contractor shall align all equipment and holding down bolts and shall inform the Engineer before proceeding with grouting-in the item or item concerned.The Contractor shall ensure that all equipment is securely held and remain in correct alignment before, during and after grouting- in.

The Contractor shall properly bed in cement grout each item of plant or its supporting base restingonfoundations,andshallgrout-inwhererequiredholdingdownboltsplacedintheholes

prepared in the foundations.The materials and workmanship used in grouting shall be such as will result in a solid anchoring of foundation bolts and complete filling of the gaps between the Plant or its base and the foundations, without shrinkage or cracking.

During erection of the Plant the Employer will inspect the installation from time to time in the presence of the Contractor’s Site representative to establish conformity with the requirements of the Specification. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the Employer.

All plant shall be installed in accordance with the recommendations or instructions of the manufacturer, for the particular application. Each mounting position shall be chosen to give correctoperationoftheequipment,easeofoperation,accessformaintenanceands ervicingand freedom from any condition which could have adverse affects.

Precautions

The approval by the Engineer of the Contractor's proposals for rigging and hoisting of any item ofplantintoitsfinalpositionshallnotrelievetheContractorfromhisresponsibilityf oravoiding damagetocompletedstructures,partsormembersthereoforotherinstalledequi pment.Heshall at his own cost make good, repair or replace any damaged or injured items whether structural, mechanical, electrical, architectural, or of any other description, promptly and effectively to the satisfaction of the Engineer.

No plant or other loads shall be moved across the floors of structures without first covering the floors with timber of sufficient size so that applied loads will be transferred to floor beams and girders of steel or concrete.If it is required to reduce bending stresses or deflection, the beam andgirdersshallbeprovidedwithtemporarysupports.AnymovementofPlantand otherloads over the floor structures shall be subject to the prior approval of the Engineer.

CivilInspection (Water Leakage Test)

Tanksandbasins

RefertoPart10B–ParticularCivilandStructuralWorksRequirementsoftheBidDocument

FieldControl Inspection

Contractorshallbeconductperiodicfieldcontrolinspectiontopreventanyfieldaccident.The Engineer shall joint field inspect or conduct unannounced inspections.

Inspectionafter Erection

After the erection of anyitemof Plant and its associated equipment has been completed, it shall be offered to the Engineer for inspection in its static state prior to commissioning the item.

Completionoferectionandprocedure priortosettingto work.

The mechanical completion of plant under erection shall be deemed to occur if all the units/systems of the Works are structurally and mechanically complete as noted below:

All rotary, static, structural equipment, piping, electrical/instrumentation and other equipment under the scope of the Contract have been erected, installed and grouted and are as per the specifications.
Allsystemshavebeenwashed/flushed/drained/boxedupwherenecessary.

All system testing including pressure, vacuum and nondestructive tests, no load tests and such other tests are completed with safety valves/relief valves set to operating conditions installed in position.

All panels, local control desks erected with power/control cableterminations withall continuity checks, insulation checks and other installation checks are carried out.

Prior to pre-commissioning checks, the Contractor shall erect the entire Plant and ensure readiness of civil works to the satisfaction of Employer, so that the Works are physically ready to undergo pre-commissioning checks.Pre-commissioning checks will include checks like no- load running of machinery, checks on instruments and electrical including calibration and loop checks, functional checks, inter-lock checks etc.

At the stage of mechanical completion of erection, the Contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the Plant is fit and sound to undergo pre-commissioning

checks.

Thefollowingdocumentationshallbecompletedbeforethe Contractornotifies Mechanical Completion of Erection to the Employer

(a) Allshopinspectionrecordscompiledandboundin4(four)copies.
(b) Allerectionandcommissioningproceduresdulyapproved.
(c) All instruction manuals in draft form - with each sheet bearing a stamp to indicate "DRAFT FOR REVIEW ONLY" submitted in 4 (four) copies.

Upon achieving mechanical completion, the Contractor shall notify the Employer of such completion of section/units/systems and readiness for inspection for acceptance of mechanical completion of erection.TheEmployer/Engineershallproceedwithinspectionofsuchsections/units/systemswithin 10 days of such notice.

Consequent to inspection, the Employer will inform the Contractor a list of deficiencies for rectification and the Contractor shall complete the rectification work within a jointly agreed period priortostart ofpre-commissioningtests.Theerectionperiodallowedbythe Contractorshallinclude all activities of mechanical completion as noted above.

SiteAcceptanceTestDocument

Fiftysix(56)dayspriortocommencementofTestsonCompletiontheContractorshallsupplyaSite Acceptance Test (SAT) Document for approval. This shall comprise four copies of the details of the inspection and test procedures to be carried out in testing the Works.

TheSATPlanshallprovidecomprehensivedetailsofthetesttobecarriedout,thepurposeofeach test, the equipment to be used incarryingout the test and the methods to be adopted incarryingout the tests. The SAT shall provide space within the documentation for results of the tests to be added and for each test and for the SAT as a whole to be signed off by the Contractor and the Engineer.

TheSATshallcategorisetestsas follows:

a) Drytests

Drytestsarethosetestscarriedoutwithoutprocessfluidbeingpresent.

b) Wettestswhichcanbefurthercategorizedas

(1) Hydraulictests

Hydraulicwettestsarethosetestscarriedoutwithpotablewaterin orderto prove the hydraulic capability of the Works.

TheContractorshallmake hisownarrangementsforwatersupply,chemical,electricpower,fuel, instrument and labour during hydraulic wet tests.

Itshallbeassumedthattheco-operationofothercontractorsinthecarryingoutofTestson Completion will not be unreasonably withheld.

Testson Completion

General

PriortothecommencementofTestsOnCompletiontheContractorshallsubmitf orapproval the following:

(1) SiteAcceptanceTest Documents
(2) As-BuiltDrawings
(3) OperationandMaintenanceManuals
(4) Sitetestresults/ datasheetandphoto

TestsonCompletionshallnotbecommenceduntiltheaforementioneddocume ntsare approved.

The initial charges of oil, grease, electrolyte, generator fuel / oil, chemical, disposal of cake,etc. necessary for Tests on Completion shall be provided by the Contractor.Raw Sewage and electricityrequiredforTestsonCompletionwillbeprovidedbytheEmployerfree ofcharge.If necessary, Contractor shall create design loading conditions for testing purposes by testing fewer than the total number of installed units of process tanks or equipment at a time. In such cases, multiple tests shall be conducted to ensure that all installed units are tested. In the event that raw sewage/influent wastewater is not available at ISPS , the Contractor shall defer testing until such time as sewage becomes available for pumping as described elsewhere in these Bid Documents. The Contractor shall provide adequate notice (this notice period shall be determinedbythenormalleadtimeforlocallypurchasedchemicalsplusatleast2

8days)ofhis chemical requirements prior to commencement of the Tests on Completion involving their use.

ThecostofchemicalsusedfortheTestsonCompletionshallbemetbythe Contractor.

Theinspectionandtestsprocedurewhichwillbecarriedoutareprovidedunderth egeneral conditions of contract and shall also consist of the following:

a) ManualCommissioningTests(Clausei)

Manual Commissioning Tests shall be such preliminary trials, tests and retests on individual items of Plant or complete systems as are required by the Engineer in order to demonstrate that the Plant as a whole is ready to undergo the Manual Operation Tests (Clause 3.11) and that these will take place with a minimum of interruption.

The Manual Commissioning Tests shall demonstrate not only the items of Plant under normal operation, but also their response to abnormal and emergency conditions.
The Engineer will notify to the Contractor which items of Plant will be tested and the extent to which they will be tested in order to fulfill the requirements of the Specification.

Leakage tests at 1.5 maximum working pressure shall be carried out on all erected pipe work prior to the Manual Commissioning Tests.

Pump curves shall be available for the Manual Commissioning Tests and all instruments essential for the tests shall have been calibrated.

a) ManualOperationTests(Clause ii)

When the Manual Commissioning Tests have been completed so that the items of Plant have been demonstrated to the satisfaction of the Employer Representative, the Contractor shall commence the Manual Operation Tests.

These tests shall demonstrate the correct operation of the whole Plant whilst using the minimum quantity of automatic control and monitoring equipment.Such equipment shall be at least that required both for the maintenance of safety and for the normal mode of operation of the Plant.

ThePlantwillberequiredtodemonstratesatisfactoryoperationatalldesignflowrates.

The tests shall be of seven consecutive days' duration; if the supply of water should fail or other matters interfere outside the Contractor's control, the tests may be of such number of broken days as the Engineer considers is the equivalent.

Theexactdateofcommencement shallbesubjecttothe approvaloftheEngineerand shall be dependent on the following conditions having been met

(1) AllrelevantitemsofPlantinapprovedworkingorder
(2) AllitemsofPlantcorrectlyidentifiedwithlabels

c) AutomaticCommissioningTests(Clauseiii)

The Automatic Commissioning Tests shall be such preliminary trials, tests and retests on individual items of Plant or complete system as are required by the Engineer in order to demonstrate that the Plant as a whole is ready to undergo the Tests of Completion (Clause 3.13) and that these will take place with a minimum of interruption.

At least one week before the commencement of these tests, the Engineer will notify the Contractor which items of Plant will be tested and the extent to which they will be testedin order to fulfill the requirements of the specification.

The Tests on Completion (Clause 3.13) as provided under the general conditions of contract-clause 37 shall not be carried out until the completion of the above tests.

(1) All pipe work shall be hydrostatically tested at site to a pressure equal to 1.5 times the maximum working pressure likely to be encountered in the system.

(2) The Contractor shall carry out all tests on the Plant and shall supply four copies of all test results to the Engineer.

(3) All tests shall be to the approval of the Engineer who may require them to be repeated, prolonged or modified as may be necessary to ensure that any or all items of Plant conform to the Contract.

(4) The Engineer shall be permitted to inspect all Plant which is undergoing tests and may himself conduct tests.

WhereitisnecessaryfortheEngineertomakearrangementsforthesupplyofwater,chemicals, power, etc., for any testing, the Contractor shall not commence the tests until after these arrangementshavebeenmadeonorafteradateagreedbytheEngineerandtheContractor shall

make no claimfor delaytosuchtestingonthisaccountexceptasprovidedfor under Clauses44 of the General Conditions of contract.

If any item of plant fails during or after testing to achieve its intended duty or otherwise proves defective, it shall be modified or altered as necessary and re-tested and re-inspected as required by the Engineer.

Vibration/noise level tests shall be carried out at site which will form basis for acceptance oftheequipment.IftheContractorisnotinapositiontomeettherequirementsgiv enbelowasper ISO 10816 – 1995, the equipment may either be rejected or the Contractor shall carry out all necessary modifications to keep vibrations within the acceptable limits specified.

Equipment	Noise Level (dBAat1.86mfro m equipment)	Velocity of vibration(mm/ sec)
All rotating equipmentnot having reciprocatingpartswithmotorkWl ess thanorequalto15kW	85	1.12
All rotating equipment not having reciprocating parts with motor kW more than15kWandlessthan orequal to 75 kW	85	1.8
All rotatingequipment not having reciprocatingpartswithmotorkW greaterthan75kW	85	2.8
Allequipmenthavingreciprocatin gparts viz. compressors,dosing pumps sampling pumps	85	-

The Contractor shall have a minimum of three commissioning engineers, one for process and plant and the other for mechanical/electrical/instrumentation works on site during all tests in order to both demonstrate the Plant and to correct any faults which may occur.

DryTestRequirements

Asaminimumrequirementthefollowingdrytestsshallbecarriedoutasagenera
l requirement:

(1) Ageneralinspectiontocheckforcorrectassemblyandqualityof workmanship

(2) Acheckonthepresenceoflubricant,coolingmedium,electrolyte, etc.

(3) AcheckonadequacyandsecurityofPlantfixingarrangements.

(4) Ageneralchecktoensurethatallcovers,accessladders,waterproo fing,guard railings etc are in place.

(5) Acheckondamp-proofing,rust-proofingandvermin-proofingandparticularlythe sealing of apertures between building structures, chambers etc and the outside.

a) CivilandBuildingWorks

Asaminimumrequirementthefollowingdrytestsshallbecarriedoutontheci vil engineering and building works:

-Checkforthepresenceofforeignbodiesinpipeworkandstructures.

b) Mechanical Works

Asaminimumrequirementthefollowingdrytestsshallbecarriedoutonthem echanical systems:

-
Carryoutpreliminaryrunningchecksasfarispermittedbycircumstancesin orderto ensure smooth operation of Plant.

c) ElectricalWorks

Asaminimumrequirementthefollowingdrytestsshallbecarriedoutontheel ectrical systems:

(1) Checkphasingand polarity.

(2) Carryoutpointtopointcheckonallcables.

(3) Checkonsecurityofcableterminations.

(4) Checkoncompletenessandadequacyofearthingsystems.

(5) Checksettingonprotectionrelays,sizesoffusesandmotoroverloadsettings.

(6) Carryoutchecksoncablingsystemsinaccordancewiththerequirementsofthe relevant standards.

(7) Checkoperationofmaincircuitbreakersbysecondaryinjectionmethods.

(8) CheckrotationaldirectionofPlant.

(9) Checkinstrumentloopintegrity,functionalityandcalibration.

(10) Checkoperationofstandbygeneratorinstallationandmains/generatorchangeover procedures;a4hourloadtest(usingthenormalloadoftheWorks)shall becarried out on the generator when the load is available.

(11) Checkplant functionality.

(12) CheckfunctionalityofthecentralMMIanditspowersupply.

Process PlantItem/Equipment

Allprocessplantitems/equipmentshallbetestedtoensuretheymeettheEmployer's Requirements for quality of workmanship, construction and performance.

HydraulicWetTest Requirements

Hydraulicwettestsshallbecarriedoutoncompletionofdrytests.

Clear Water shall be used for hydraulic wet tests. The purpose of the tests is to prove the hydraulicperformanceoftheWorks.Inordertodemonstratethis,theContractorshallensure that each part of the Works is hydraulically loaded to its rated throughout for a period of at least four hours.

In order to ensure a sufficient supply ofwater to carry out these tests the Contractor shall provideallrequiredfacilities,includingbutnotlimitedtoanytemporaryfacilitiesthatmaybe required for storage and recycle of Clear Water or facilities for the disposal of the water off Site in an approved manner.

Thefollowingtestsinteraliashallbecarried out:

(1) Pressuretestingofallpipedsystemslaiddirectingroundinaccordance with the relevant standards.
(2) Fillallstructuresandcheckforleaks.
(3) Fillingofallstoragevesselstocheckforleaksand distortion.
(4) Runningofpumpedsysteminordertocheckfor.
    i) Correctfunctionality.
    ii) Absenceofleaks.
    iii) Correctrunningtemperatures.
    iv) Smoothnessofrunningandtheabsenceofunduevibrationorstress.
    v) Checkdriverunningcurrents.
(5) Carryoutcalibrationofinstrumentswhereappropriate.
(6) Carry out valve operation, diversions etc. to fully hydraulically load each processelement(orwherethereisarequirementtowithstandaoverload), overload each process element.
(7) Demonstratecorrectfunctionalityofelectrical,controlandinstrumentation systems.

TheContractorshallsimulatetheconditionsthatwillprevailwhenoperatingasa process in order to demonstrate the correct functionality of process control loops etc.

During these tests a check on the performance of Plant shall be made to compare its site performancewiththefactorytestdataandtoidentifyanyconstraintsonperformance dueto site conditions.

Safety Audit

Aftersatisfactorycompletionofhydraulicwettestsandpriortointroductionofprocessfluid to the plant a safety audit shall be carried out to ensure compliance with the necessary requirementforsafetyandfor operation of Plant.The safetyaudit shall be documented.The safety audit document shall be approved by the Engineer prior to commencement of Plant commissioning.

ProcessWetTests(withRawSewage)

OnapprovalbytheEngineertheContractorshallcarryoutprocesswettests.

Raw Sewage shall be used as the main feed stock for process wet tests. These tests shall be carriedouttodemonstratetheprocessperformanceoftheWorks.Themultiplettestsshallbe conducted to ensure that all installed units are tested.

TheContractorshallprovideallrequiredfacilitiesforthedisposaloffSiteinanapproved manner.

Thefollowingtestsinteraliashallbecarried out:

(1) Checkforleaksonvessels,structures,pumpsandpipe work.
(2) Runningofallpumpedsystemsinordertocheck for.
    - ✓ Correct functionality.
    - ✓ Absenceofleaks.
    - ✓ Correctrunningtemperatures.
    - ✓ Smoothnessofrunningandtheabsenceofunduevibrationorstress.
    - ✓ Checkdriverunningcurrentswherethesolutionpumpedisdifferentfrom that pumped during hydraulic wet tests.
(3) Carryoutcalibrationofinstruments.
(4) Carryoutvalveoperation,diversionsetc.tofullyhydraulicallyloadeachprocesselement (or where there is a requirement to withstand an over load), overload each process element.
(5) Demonstrate correct functionality of electrical, control and instrumentation systems not checked during dry or hydraulic wet tests or which may have changed as a result of the different operating conditions now prevailing.

OncompletionofthetestsonthevariouspartsoftheworkstheContractorshallrunthepl antasa whole in order to demonstrate the full functionality and performance of the Works at various throughput rates for a continuous period of not less than 30 days.

Co-operationwithotherContractorsin theExecutionof their Tests

TheContractorshall,whererequired,assistothercontractorsincarryingoutth eirtestson completion and or tests after completion.

Where this assistance does not constitute part of the Contractors own work associated with TestsonCompletionorTestsafterCompletiontheContractorshallbereimburs edattherates approved by the Engineer.

TestsAfter Completion

General

On successful completion of “Test on Completion” the Contractor shall carry out over a period of time not exceeding six months two separate 30 days operational tests.These tests aftercompletionshallbeundertakeninaccordancewithClause11oftheGeneralConditions of Contract.

The timing of the tests shall be determined by the Employer who shall give notice to the ContractorinaccordancewithSub-clause11.1oftheGeneralConditionsofContract.The total time for carrying out the tests shall not be less than six calendar months. .

On commencement of each 30-Days test the Employer shall allocate a continuous period of notgreaterthan60daystocompletethetest.Anyfailuretoperformduringthe60 daysperiod shall restart the ‘30 day clock’. If the part of the Works fails to pass the test in the 60 days period the test shall be deemed as a failure and the Contractor shall carry out any necessary remedial work to the satisfaction of the Engineer before the Contractor restarts the test.

AllconsumablesexceptpowerneededforoperationoftheWorksshallbeprovidedbythe Contractor.

TheContractorshallprovideallfacilitiesandequipmentnotsuppliedunderthecontractand which are deemed necessary for the Contractor to carry out and monitor the Tests after Completion.

(1) OperationalCost Criteria

The ISPS shall have fulfilled the operating cost criteria if the operating costs determined duringtheTestsAfterCompletionareinagreementwithorlessthanthosedetailedinthe Contractor’s Functional Guaranteeoran amount of liquidated damages are agreedbythe Contractor and the Engineer to compensate for any short fall in performance up to an agreed maximum amount if stated.

(2) ISPSReliability Criteria

ApartoftheWorksshall bedeemedtohavefaileditstest if:

(1) AsingleitemofPlant /equipmentfailsmorethantwiceduringthetest.

(2) MorethanfourindividualPlantitems/equipment fail.

An item of Plant / equipment shall be deemed to have failed if manual intervention is required in order to restore the Plant / equipment to its fully operational state: i.e. the failureofadutydrivewillbeconsideredasonefailure,ifthestandbydrivefails tostart that will be considered as a second failure.

PerformanceCertificate

TheconditionsforissuanceofaPerformanceCertificateasdetailedinClause12ofthe Conditionsof Contract shall inter alia comprise:

a) Thecompletionofthesixmonthsoperationofthe Works(TestsafterComple tion)tothe satisfaction of the Engineer.

b) TheO&MManualshavebeenupdatedfollowingoneyear’soperationalexp erience and approved by the Engineer.

c) AlldefectsidentifiedpriortoTakingOveranddefectsidentifiedduringoneye aroperation of the Works have been rectified.

d) AllTests“AfterCompletion”havebeencompletedtothesatisfactionoftheEngineer.

e) AlltrainingdetailedintheEmployer’sRequirementshasbeencompleted.

EndofPart14

PART15

TRAININGREQUIREMENTS

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PART 15

TRAININGREQUIREME

NTS

TrainingRequirements

General

The Contractor shall provide comprehensivetraining for the different categories of the Employers operationandmaintenancestaff.Trainingshallfallintotwomaintypeswhichare‘offthejob’and ‘on the job’. Off the job training shall take place in the class room and on the job training shall be carried out on the running plant(s).

OffTheJob Training

TheContractorshallpreparеformaltrainingdocumentationfordistributiontothetrainees.Visualaids shall be used to illustrate the points being made and to make the training programme interesting and enjoyable for the participants.

Theoffthejobtrainingshallcomprisethefollowing:

1. OfftheJobTrainingProgrammeforallTrainees

Toprovidetraining:

a) regardingbasicfeaturesoftheelectro-mechanicalandinstrumentationequipmenttobeinstalled
b) healthand safety;
c) plantsafetyprocedures;
d) on theuseofthe HMIsystem.
e) Monitoringdevices;
f) Operationalperformanceindex.

2. OfftheJobProcessTrainingProgrammeforOperators

Toprovidetraining:

a) ontheoperation of individual itemsof plant and sections of the Works including automaticoperation and manual operation;
b) onthedaytodayoperationoftheWorksandprocedures;
c) on a comprehensive list of ‘what if’ scenarios dealing with the actions to be taken in the event of potential process problems, alarms, plant failures, overflows, power failures etc.;
d) onfirstlinemechanical maintenance;
e) safeworkpractices;
f) onsafetyprocedurestobefollowedinoperating,maintaining,andcleaningtheplant;
g) specialprocedurestobefollowedintheeventofachlorineleak.
h) CreationofO/Mforms;
i) Troubleshooting.

3. OfftheJobTrainingProgrammeforElectricalMaintenanceStaff

Toprovidetraining:

a) ontheconfiguration,constructionandoperationoftheelectrical Plant;
b) ontheelectricalmaintenancerequirementsoftheWorks;
c) ontheswitchingandsafetyprocedurestobefollowed;
d) safemethodsof working;
e) onfaultfindingandrepairprocedures.
f) CreationofO/Mforms;
g) Troubleshooting.

4. Off the Job Training Programme for Control and Instrumentation (ICA) Maintenance Staff (Refer clause no. 15.7 below)

5. OfftheJobTrainingProgrammeforMechanicalMaintenanceStaff

Toprovidetraining:

a) ontheroutinemechanicalmaintenancerequirementsoftheWorks;
b) onlubricationrequirementsoftheWorks;
c) onfaultfinding,repairandoverhaulprocedures;

d) Cleaning&maintenancemethod;
e) safemethodsof working
h)CreationofO&Mforms;

g)Troubleshooting.

6. OfftheJobTrainingProgrammefor
IntermediateSewagePumpingStation(ISPS)Staff To provide training:

a) processmanagementtechniques;
b) plantcostmanagement;
c) safemethodsofworkgeneral;
d) onsafetyprocedurestobefollowedinoperating,maintainingandcleaningthe plant
e) Cleaning&Maintenancemethod;
f) CreationofO/Mforms;
g) Troubleshooting.

OnTheJob Training

TheContractorshallutilisetheOperationandMaintenanceManualsastheprimarytr
ainingaidin carrying out the on the job training. Shortcomings, omissions and errors identified in the O & M Manuals during the training shall be rectified prior to final acceptance of the O & M Manuals.

1. OntheJobTrainingProgrammeforallTr
ainees To provide training:

a) plantfamiliarisationtour;
b) on theuseofthe HMIsystem;
c) healthand safety;
d) Identifyareaswherespecialsafetyprecautionsarenecessary.

2. OntheJobProcessTrainingProgrammefor Operators

Toprovidetraining:

a) under operational conditions on the operation of individual items of plant and sections of the Works including automatic operation and manual operation;

b) illustratebyexample thedaytodayoperationoftheWorksandprocedures;
c) illustrate by example the actions to be taken in the event of potential process problems,alarms, plant failures overflows, power failures etc. (as identified in the ‘what if’ scenario off the job training);
d) illustratebyexamplethefirstlinemechanical maintenance;
e) illustrate by example safety procedures to be followed in operation, maintenance and cleaning of the Works;
f) Operationatthetimeofchangeofinflowload;

g) EvaluationofProcessMonitoring;
h) Waterqualitytesting;
i) Entryandevaluationofeverydayperformancedata;
j) Creationofvarioustypesofareportofaday,monthly,andafiscalyearusing PC.

3. OntheJobTrainingProgrammeforElectricalMainten

anceStaff To provide training:

a) carryoutdetailtouroftheelectricalplant;
b) illustratebyexampletheoperationoftheelectrical Plant;
c) illustratebyexampletheelectricalisolationandmaintenanceprocedures;
d) illustratebyexamplefaultfindingandrepair procedures;
e) illustratebyexample switchingandsafetyprocedurestobefollowed;
f) illustratebyexamplesafesystemsof work;
g) Entryandevaluationofeverydayperformancedata;
h) Creationofvarioustypesofareportofaday,themonthly,andafiscalyear.

4. On the Job Training Programme for Control and Instrumentation Maintenance Staff (Refer clause no. 15.7 below)

5. OntheJobTrainingProgrammeforMechanicalMaintenanceStaff

Toprovidetraining:

a) illustratebyexampletheroutinemechanicalmaintenancerequirementsoftheWorks;
b) illustratebyexamplelubricationprocedures;
c) Illustratebyexamplefaultfinding,repairandoverhaulprocedures.
d) Illustratebyexamplesafesystemsof work;

e) Entryandevaluationofeverydayperformancedata;

f) Creationofvarioustypesofareportofaday,themonthly,andafiscalyear.

TrainingProgramme

OffthejobtrainingshallbecarriedoutpriortoTakingOveroftheWorksoranysectiono fthe Works.

OfftheJobtrainingshallbecarriedout priortoOntheJobtraining.OntheJobtrainingshallbe completed as a condition for acceptance of the Works following completion of the Tests after Completion.

TheContractorshallprovideatrainingplanforeachcategoryofstaff.Thetrainingpla nshall detail thecontentanddurationofeachcourse.Thetrainingplanshallbesubmittedforthea pproval ofthe Engineeratleast 120 daysprior to the commencement of theTestson Completion. The duration of training offered for each category of staff shall not be less than that detailed in the following table.

CategoryofStaff	OfftheJob (minimumdaysdurationforea ch course)	OntheJob (minimumdaysdurationfo r each course)
Allstaff	1	1
Operator	1	2
Electricaltechnician/ electrician	1	2
Control/ instrumenttechnician	1	2
Mechanicaltechnician/ fitter	1	2
ISPS management	1	(seenote)

Note:ItisassumedthatISPSmanagersonthejobtrainingwillbecontinuousthroughou t12monthsin a calendar year when the plant(s) is operated by the Contractor.

The training day shall be assumed to be not less than 6 (eight) hours split into two sessions. The Contractor shall provide facilities for training which shall include inter alia the training rooms/locations,tablesandchairs,projectors,white/blackboards,trainingaids,trainingmanuals etc.

Where trainees of a given category can all be released from their Works operational duties simultaneouslytheymaybetrainedtogether.WherethisisnotpossibletheContractorshallrepeatthe complete course for those who could not attend.

TrainingPersonnel

TheContractorshallprovidesuitablyqualifiedtrainerstocarryouttheoffthejobandonthejob training.

Thetrainersaretobeexperiencedinsewagepumpingstationmanagement,operationandmaintenance in their relevant discipline and in the training of skilled and unskilled staff.

The Contractor shall submit the curriculum vitae of the trainer nominee's to the Engineer for approval 120dayspriortothecommencementoftheTestsonCompletion.Thetrainingexpertshallbefluent in English, Hindi and Kannada Languages or the Contractor shall provide the services of an interpreter during the training periods.

Instrumentation,Control&AutomationTrainingrequirements

The Contractor/ system supplier shall conduct training courses for personnel selected by BWSSB. TrainingshallbeconductedbypersonnelemployedbytheContractor/systemsupplierfamiliarwith the system supplied and who have experience and training in developing and implementing instructional courses.

Theentirecostofthecompletetrainingprogramme,includingreasonableperdiemexpensestocover meals,lodging,transportandsimilarexpensesforallBWSSBpersonnelandtheconsultantsattending thetrainingprogram,shallbetheresponsibilityofthe Contractor/

systemsupplier andshallbeincluded in the contract price.

TheContractor/ systemsupplier shallsubmitinformationonthetrainingprogrammeforapproval,prior toshipmentoftheequipment.Thissubmittalshallincludeacourseoutline;timerequired,course schedule,sampleworkbookandinstructorqualificationinformationforeachlevel.

TheContractor/ systemsuppliershallmakeaworkbookoneachcourseavailabletoeverypersontaking thecourseslistedherein.Theworkbookshallbeofsufficientdetailsothat,atalaterdate, atraineecould reviewin detail the major topics of the course.

ThetrainingtimesshallbescheduledbytheBWSSBinadvancewiththeContractor/ systemsupplierso asnottodisrupttheBWSSB’sabilitytooperatetheplant.

OperationsandMaintenanceTraining

Trainingshallbeprovidedforfive(5)oftheBWSSBpersonnelattheContractor/ systemsupplier facility on operations and maintenance of all system components of ISPS

Themaintenancetrainingprogramshallbedevelopedforpersonnelthathaveelectronicsmaintenanceand repairexperienceandageneralknowledgeofcomputersystems,butshallnotassumeanyfamiliaritywith the specific hardware furnished.

Asaminimum,thefollowingsubjectsshallbecove

red: System Architecture and Layout

HardwareComponents

Module Switch Settings (Configuration

Switches) I/O Modules

PowerSupplies

DataHighway:

Programmerconnection

IOP programming and diagnostic

techniques Battery replacement and

recharging

PC and workstation familiarization and

maintenance: Troubleshooting

Disassembly

Cleaning

ComponentReplace

ment Re-assembly

Theoperationtraining programmeshallincludethefollowingtopics:

Power-

up,bootstrappingandshutdownofallhardwaredevi

ces Interpretation of all standard displays

Appropriateactionsforsoftwareandhardwareerror

occurrences Use of operator interface displays

andkeyboards

Useofprinterincludingreplenishmentofs

upplies Manual data entries

Creationandeditingofgraphicoperatordisplays

creens. Loading of any required software

into the system

Databasecreationandediting.

TrainingAssessment

Attheconclusionofoff-jobandon-
jobtraining,allthetraineesshallbeaskedtoundergoasimple
assessment/testtoexaminethelevelofunderstandingoftheworkingofanISPSandthee
ffectivenessof
thetrainingprogram.Thefeedbackgatheredfromtheassessment/testshallbeusedby
theManagersto makeadecisionwhethersomeofthetraineesneedtobere-trained.

Themanagerswhowillbeacontinuoustrainingfor12monthperiodwillhavetobeassess
ed/testedafter completion of the 12 month period.

Thecontractorshallpreparetheproposedassessment/
testingquestionnaireandsubmitforapproval before commencement of the training

program.

EndofPart15

PART16

OPERATIONANDMAINTENANCE

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PART16

OPERATIONANDMAINTENANCE

This section applies to the specifications of materials used for operation and maintenance, the workmanship, period for routine maintenance, maintenance of records, and responsibilities duringoperationandmaintenanceperiod.TheContractorshallprovide accesstotheSiteforthe Engineersfor the purpose of monitoringthe Contractor’s OperationandMaintenance activities. TheContractor shalltrain the BWSSB personnel whowilloperate the plants forthe last year of the 5-years Operation and Maintenance period.

OperationandMaintenance Requirements

The Contractor shall operate and maintain all the works of the Intermediate Sewage Pumping Station(s) (ISPSs) under the Contract complete including the road works, landscaping, civil/structural, mechanical components instrumentation system, Electrical System of ISPS, SCADA HMI systems, all utility and ancillary buildings, ISPS premises area for the period of Five(5)yearsfromthedateofsuccessfulcompletionof"TestsafterCompletionoft heWorks".

The Contractor shall make his own arrangements at his own cost for plant operation personnel, lubricants, diesel, spares, tools and tackles, routine maintenance, screenings collection, transportation and disposal, co-ordination with BWSSB, Karnataka Power Transmission Corporation Ltd. (KPTCL) authorities and any other activity required for the operation and maintenanceoftheworks/plantsinfullcompliancewithallapplicablerules,regul ations,laws, codes, requirements and any other limitations.

Thedieselhourstobeconsideredinestimatingthepowerbreakdownperiodisasunder:

Normally Shut down time shall be considered as Average 2 hrs. per day on Monthly basis. Contractorshall payfordieselchargesforrunningtheISPSfor thisperiod.BWSSBwillpayfor any additional consumption of diesel when power shutdown period exceed 60 hours per month.

ThecostofelectricalenergyconsumedfortheoperationofthePlantwillbeborneby

BWSSB
uptotheamountcorrespondingtotheguaranteedspecificenergyconsumptionsp
ecifiedbythe

ContractorintheTechnicalScheduleorasagreedbetweenBWSSBandtheContractor.The Contractor shall bear additional electrical energy consumption chargesabove the amount indicated above.

DuringtheOperationandMaintenanceperiod,theContractorshallcollect,transport,anddispose of the screenings in full compliance with all applicable laws, rules, and regulations.

The Contractor shall submit a weekly report to the Employer detailing the Operation and Maintenance indicating the labour hours expended, Electrical Power Consumed, Chemicals and other Consumables consumed and also any problems including troubleshooting faced and rectified. The report shall also include full details including photos and complete results of all sampling and analysis conducted. The sampling locations, parameters analyzed, and sampling/analysis frequencies shall be as listed in the “Sampling/Analysis Locations and Frequencies” table in the “Sampling and Analysis” section of Volume 2, Section 4, Part 14 of these bid documents, at a minimum.

TheContractorshallsubmitdetailedschedule/manualofallO&Mactivities andcontentswith references of equipment manufacturers maintenance schedules/manuals to the employer for review and approval.

TheContractorshallcarryoutallO&MactivitiesaspertheapprovedOperational Maintenance Manuals.

TheContractor’sresponsibilityshallalsoincludethesafetyandsecurityoftheworks/plants during the course of Operation and Maintenance.

DuringOperationandMaintenanceperiod,theContractorshallappointaPlantIn-Chargeand Lead Operator. In addition, the Contractor shall appoint suitable number of operators, fitters, electricians, helpers, gardeners, office peons, security guards, labourers as required for the operation and maintenance of the plants for three shifts and adequate other staff / supporting personnel during general shift.

KeyO&Mpersonnelshallhaveminimumqualificationandexperienceasgivenbelow:

MinimumStaffandQualificationsRequirementsduringO&MPeriodforISPS

Sr. No.	Designation	Qualifications	Experience in Years	Total No.
1	PlantSupervisor/ Superintendent	GraduateinCivil	5	1
2	Shift-in-charge	DiplomainCivil,PublicHealth, or Environmental Engineering	5	3 (Three Shifts,1for each shift)
3	A)Operatorsfor Koramangala Sports Complex (KSC) ISPS	DiplomainMechanical/ Electrical Engineering	3	3for KSC ISPS
4	Electrician	Diploma/ITICertificationin Electrical Engineering with experienceinISPSErection, Testing, Commissioning, Operation & Maintenance.	3	1
5	Instrumentationand Control Technician	Diploma/ ITI Certification in Instrumentation and Control Engineeringwithexperience in ISPS Erection, Testing, Commissioning, Operation &Maintenance.	3	1
6	Fitter/Mechanic	Diploma/ ITICertification in MechanicalEngineeringwith experience in ISPS Erection, Testing, Commissioning, Operation & Maintenance.	3	2
7	Peon	10^{th}Pass	2	1
8	B)SecurityGuards forISPS	8^{th}Pass	3	3

Note:

a. Theaboverequirementisminimumonly.TheContractorwillarrangeextraworkforce, as and when required, so as to smoothly run the operation and maintenance including preventive maintenance, repairs etc. and general cleanliness of the installations.

b. The above staff strengthisexclusive of leave reserve requiredfor different category of staff.TheContractorshallensureavailabilityofthepersonnelgiveninthe abovetable for all seven days in a week.

c. TheContractorshallmakeappropriatearrangementsformaintenanceofitemslike roadwork,buildings,arboriculture,patrollingandmaintenanceofcivilstructures, vehicle operations and other activities defined to fulfill its obligations under O&M Contract.

TheContractorshallfurnishcompleteresumes/ biodataforallpersonnelproposedtwomonths before the start of Operation and Maintenance period to the Engineer for approval.

TypicalitemsinISPS&theirchecks

Thepurposeofmaintenanceisshownbelow.

-Pumpupsewagetosewagetreatmentplantetc.

Maintenanceandmanagementoffacilitiesaredividedintooperationsurveillanceworkand preservation work.

- Operationsurveillanceworkisthesurveillanceofapparatusoperation,apparatusoperation atthetimeofusual,apumpingmodeatthetimeofaheavyrain,andcorrespondenceatthe time of a power failure.

- Preservationworkisinspectioncheck,aperiodiccheck,apparatusmaintenance,repairof failure apparatus, cleaning, etc.

Theitemofthemainpreservationworkisshownbelow.

Nameof Facility	Daily	Periodic	
	Pointtobechecked	Frequency	**Pointtobechecked**
MotorisedGates	-CheckSmooth-Operation -Checksafetyequipment	Weekly	-CheckGreasesup&Oils -Smoothnessofoperation (Fully open & Close)
		Monthly	-Checkopening-and- closing time
Wetwell,Channels and Chamber	-Removaloffloatingmatter -Checkofawaterlevel	Asneeded basis	-Cleaningofasediment -CheckH_2Sgas concentration
Coarse screens	-CheckSmooth-Operation -Checkofthedifferenceof the water level before and behind a screen -Remove un-removable floatingmatteronscreens -Clean-updropgarbage -Clean-upTopofScreen -Checkabnormalnoise -Checksafetyequipment -Checkmanualcleaning equipment Correctness	Monthly	-Adjustmentoftake-upfor Drive chain -CheckScreen-shape -CheckOperationofa wiper -Adjustment of space betweenrakesandascreen -Check of the lubricating oillevelofreductiongears -CheckRake-speed -Checkemergencystop system
ScreeningConveyor	-CheckSmooth- Operation- Abnormal noise -Meanderingofabelt -Checkscraper performance -Checkrollers-performance	Weekly	-Greaseup&Oils

Nameof Facility	Daily	Periodic	
	Pointtobechecked	Frequency	**Pointtobechecked**
	-CleaningofConveyor -Checksafetyequipment		
		Monthly	-CheckDamagetoabelt -CheckSlackofabelt& adjustment of take-up -Checkofanemergency shutdown system -CheckBelt-speed
SubmersiblePumps	-CheckSmooth-Operation -Check discharge rate, pressure,abnormalnoise, Vibration -Check up minimum submergenceinwetwell -Checksafetyequipment -Positionofvalve	Monthly	-Checkpump damage -Check the pump lifting equipmentforperformance and smoothness
		Every 6 Months	-Checkwearonpump impeller -CheckOillevelandgrease up -Checkbearings
		Every1 ~3 Year	-Checkpumpperformance & wear on pump impeller
Monorail MotorizedHoist	-CheckSmooth-Operation -Checkallliftingequipment including wire and hook -Checkliftingandtraveling performance -Checksafetyequipment	Monthly	-CheckEnd-stop system
		Asneeded basis	-Checktravelingspeed -Checkhoistrails,structure & support -Checkdeflectionofgirder
Valves	-Checkwaterleakage	Asneeded basis	-Checkseal -Checkdamage

Operation&Maintenancepractices(Electrical)

TypicalitemsinElectricalFacility&their checks

Daily		Periodic	
Frequency	Description	Frequency	Description
Transformer	Verification of KVA, V, A, abnormalsound,currentprotection, oil temperature	Every 6 Months	Verification ofgeneral performance, Verificationofoillevels,silicagelin breather,OLTC,OTI,WTI,Buchholz relay,CTs etc, testing of oil,verificationofearthconnections,IR measurement .
11 kV Switchboardand Switchgears	VerificationofkVA,kW,kWhV, A, PF, Hz,healthiness of protections, indications, alarms,abnormalsound,burning smell.	Every 6 Months	Verificationofconditionofbreakers, switches, relays, protective devices, earthing, wiring and connections.
PCC /MCCs/MLDB	VerificationofV,A,healthinessof protections, lamps, abnormal sound, burning smell	Every 6 Months	Verification of condition of breakers, switches, pushbuttons, relays, protectivedevices,earthing,wiringand connections
Lightingpanels	Verificationoflamps,abnormal sound, burning smell.	Every 6 Months	Verificationofconditionofbreakers, switches, earthing, wiring and connections.
Metersreading	VerificationofV,Am,overload protection	Every 6 Months	Verification of over load protection indication,switchOn/Off,accuracy, damage

Diesel Generator Set	1. Verification of Engine oil level, Engineoilleakage,air&oilfilters, coolingfans,fuellevel,waterlevel etc. 2. Verificationofbatteryvoltage, charging & self start. 3. Verificationofabnormalsound, vibrations etc. 4. VerificationofVoltage,current, frequency, RPM, Indications, Alarms & Protections. 5. VerificationofOilleakage,fuel leakage. 6.VerificationofInterconnecting Cable, earthing, loose connections etc .	Every 250hours/6 Months	1. VerificationofConditionsof filters. 2. VerificationofConditionofcooling fan. 3.VerificationofConditionofbattery & charger. 4. Verificationofselfstart system 5. Verification of condition of engine, alternator & accessories, doors of acousticenclosure,exhaustsystemetc. 6. Verification of conditions of Breakers,Switches,PushButtons, Relays etc. 7. Verification of Auto / Manual operation,allinterlocks,synchronising. 8. VerificationofIndications, Alarms&Protections. 7.VerificationofConditionof InterconnectingCables,Connection& earthing,includingNeutralEarthingof AC Generator.
Cablesystem	Verification ofshort circuit, burningsmell,looseconnections, local heating	Every 6 Months	Verificationofvoltagedrop,damage, insulation resistance
Lighting Fixtures	Verificationofworkingoflamps&ballasts.	Every 6 Months	1.Verificationofilluminationlevel 2. Verificationofconditionoflamps&ballasts. 3.CleaningofLightingfixtures. 4.Verificationofwiring.
Switchboard	Verificationofoperationof switches, sockets.	Every 6 Months	1. Verificationofconditionofswitches, sockets & fan regulators. 2. Verificationofwiring.
Switch Socket	VerificationofoperationofSwitch & Socket.	Every 6 Mont	VerificationofconditionofSwitch &Sockets

		hs	

Ceiling Fan	VerificationofoperationofFan.	Every 6 Months	1. Verificationofcondition ofceiling fan. 2. Verificationofconditionofbearing, abnormal sound /noise.
Powersockets	VerificationofoperationofMCB, Plug&Socket .	Every 6 Months	VerificationofconditionofMCB, Socket & Wiring.
General	1. InspectionofGeneralappearance of various Electrical equipment /items. 2. VerificationofCableSystemfor Short circuitsmell, damage etc.	Every 6 Months	1.Verificationofconditionofcables, wires& connections. 2.VerificationofInsulationresistance of individual equipment, cables and total system. 3. VerificationofConditionofEarth Connections.

ElectricalSystemOperationPractices

- All the electrical equipments shall be handled and operated by a trained and authorized person only. All the equipment shall be checked for its proper earthing and loose connections prior to start the equipment. Naked wire, loose connections and faulty connections shall be repaired immediately prior to start for operation.
- Electrical sockets and switch shall not be touched by bare or wet hands. If there is any live wire found naked or on wet ground, main switch shall be turned off first then the wire shall be repaired or moved.
- For any electrical works proper insulated tools shall be used. Do not try to use tools made for other purpose; it may be hazardous.

Operation & Maintenance practices (Instrumentation, Control &Automation)

(d) Generalmaintenance

A comprehensive maintenance program is critical to attaining long-term reliable performance of HMI Systems / ICA systems. Periodic device

calibration, preventive maintenance, and testing allowpotentialproblemstobeidentifiedbeforetheycancausemissionfailure.Promptcorrective maintenance assures reliability by minimizing downtime of redundant components.

The EPC or Turnkey contractor has to enter in to AMC contracts with system / equipment suppliersofICA,asnecessary.Itismandatorytoenterintoanagreementfora5year soperation and maintenance contract with the instrumentation, PLC and HMI system supplier and wireless communication supplier or the authorized system integrator, whosoever has executed the work for this project.

(e) Preventivemaintenance

TheHMIsystemshouldbepartoftheoverallpreventivemaintenance(PM)progra mfor the facility.

Tablebelowprovidesalistofrecommendedmaintenanceactivitiesandfrequenci esforICA systems

andtheir components.

Preventive maintenance schedules for ICA components and subsystems should be coordinated withthoseforthemechanical/electricalsystemstheyservetominimizeoverallsch eduleddown time.

Activity	Frequency
PneumaticSystems/Components/ Instruments	
CheckRegulatorsandFilters	Monthly
InspectTubingandPiping	Monthly
ActuatePressureSwitches	3 months
CalibrateSwitchesandSensors	Yearly
CalibratePressureGauges	Yearly

Activity	Frequency
CalibrateLevelTransmitters	Yearly
CalibrateFlowtransmitters	Yearly
CalibratePressureTransmitters	Yearly
ElectronicSystems	
LampTest/VerifyIndicators	Monthly
InspectEnclosuresforDirt,Water,Heat	Monthly
RunPLC Diagnostics	3 Months
CalibrateSensorsandTransmitters	Yearly
CalibrateMeters	Yearly
PLCCommunicationModules	Monthly
PLC Batteries	Yearly
TestAutomaticcontrolSequences	Monthly
VerifyAlarms	Weekly
SoftwareMaintenanceandPatching	3months
Anti-virusDefinitionUpdates	Monthly
InspectWire,Cableand Connections	Monthly
IntersiteCommunicationNetwork	Weekly
DeadBusRelays	3 Months
UPSsettingwithHMI	Weekly
PLCPowerbackup	Monthly
HMIcommunication	Monthly
WirelessNetworkRedundancy	Weekly
PLC Standalone	Monthly
DataArchiving	Monthly

a. ManycomponentsofHMIsystems,suchasdead-busrelays,arenotrequiredtofunction under

normal
systemoperatingmodes.Forthisreasonthesystemshouldbetestedperiodicallyu
nder actual or

simulatedcontingencyconditions.Thesetestsshouldapproachascloselyaspos
sibletheactual off-

normalconditionsinwhichthesystemmust operate.

b.Periodicsystemtestingprocedurescanduplicateorbe
derivedfromthefunctional performance

testingprocedures.

c.TheHMIsoftwaremaintenanceshouldincludetimelyupdatesofanynewversionsfromthe

supplier and testing to verify proper installation on the touch screen computer. In addition, software antivirus updates should be maintained. This should be performed any time after the computer is connected to the Internet or the antivirus patch should be downloadedas and when theupdatesareavailable.NormaloperationrequiresthattheHMIcomputernotb
econnectedto the Internet.

FaultyInstruments,sensors,transmitters,communicationmodules,computerha
rdwareshouldbe replaced with new components. Repair of the items would not be accepted.

(f) Reliabilitycenteredmaintenance

Reliability-
CenteredMaintenance(RCM)isanapproachfordevelopinganeffectiveandeffici
ent maintenance program based on the reliability characteristics of the constituent parts and subsystems, economics, and safety. RCM provides a logical, structured framework for determining the optimum mix of applicable and effective maintenance activities needed tosustain the operational reliability of systems and equipment while ensuring their safe and economical operation and support.

AsignificantbyproductoftheapplicationofHMIsystemstothecontroloffacilitiesi
sthelarge amount of operational data made available through the trending and data storage features of the HMI. This operational data can be used for automated performance monitoring of mechanical and electrical systems that can support a RCM approach.

ThecontractorshallhighlightthedetailsoftheproposedRCMtechniquesinthe bid.

(g) Operationsandmaintenancedocumentation

ThecontractorshouldperformanO&Manalysistodeterminethe O&Mdatarequiredto support

maintenanceoftheHMIsystem.ThisanalysisshouldbecoordinatedwithBWSSBtodetermine maintenance parameters and O&M data that are available. Typical O&M data requirements include the following items:

a. SystemdocumentationasdefinedinFDS,FAT&SATdocuments

b. Minimumspareparts list.

c. Recommendedspareparts list.

d. Recommendedonsitetestequipment.

e. RecommendedO&Mtraining.

f. RecommendedO&Mtobeperformedbycontractor

(h) Sparepartsstocking

Anadequateon-sitestockofsparepartsisessentialtoobtainninghighavailabilityofICA systems.

All spare parts used for the equipment in the maintenance of the system must be from the manufactureroftheequipmentor,iftheequipmentitselfhasbeenmadewithparts fromother manufacturers, the parts must be of the same make as used in the equipment supplied and installed.

All spare parts shall be packed for long storage under the climatic conditions prevailing at the Site.Eachsparepartshallbelabelledontheoutsideofitspackingwithitsdescription,number and purpose and, if more than one spare is packed in asingle case, a general description of the case contents shall be shown on the outside and a packing list enclosed.

Minimumrecommendedstockinglevelsincludethefollowing.Thesequantitiesmayneedtobe increased for components which are used in large numbers in the facility:

(1) Manufacturer’srecommendedsparepartslist.

(2) Oneeachofalllinereplaceableboardsor modules.

(3) Sixeachpowerandcontrolfusesusedinthesystem.

(4) Toolsrequiredtoterminatecoaxialonfiberopticcables.

Automation:

(1) Licensesforallsoftwareinstalledonthesystem.

(2) Permissiontomodifyprogramcode.

(3) Sparecablesforconnectingcomputerto controllers.

(4) PLCCPU,Powersupplymodule,DI,DO,AI,AOmodules,Communic ationmodule, protocol converter etc..

(5) PLCbatteries,fuses,etc.

(i) Utilities&Consumables

Thecontractorhastoprovideconsumablesforprinterse.g.:Inkcartridges(color &B/W),A4, A3, A1 size of paper, dot-matrix print paper for a period of 5 years.

Downtimeoftheabovesystemshouldnotexceedmorethan2 hours.

(j) Technicalsupport

TheContractorshouldspecifyfunctionalareasoftheoperatingsystemand/ orequipmentwherea

technicalrepresentativewillbefurnishedbythemanufacturerfortraining,test,c heckout, validation, or pre-operational exercises.

OngoingO&MofHMIsystemsoftwaremayrequiretechnicalsupportfromthesy stemvendor or from agency technical personnel not located at the facility. Commercial HMI software typically has provisions for remote modem access that permit this type of support from the vendor’s location or an agency central engineering group.

Suchremoteaccessprovisionsrepresentavulnerabilityto“hacking”andmustbeu sedwithgreat caution. They should be monitored when in use and physically disconnected when not in use.

PasswordprotectionpoliciesforallHMIsystems,includingPLC’s,shallbeincomp

liancewith Established policies and to be agreed with the employers

representative.

Thesepoliciesrequirethatthedefaultpasswordthatcamefromthecontrolsupplierbechanged when

Placedintooperationatthe facility.

Note:-

(a) DuringTrialrun,testing,InstallandcommissioningoftheCharges/ Coststowardsthe following items shall be borne by the contractor.

- Softwareupdates,consumablesandstationeriesetc.,
- Instrumentation(Analog)&ControlCablesandPowerCables,OFC,etc.Ifanyrequired.
- PaintingforfieldInstrument enclosures.
- ISPSprocess data transmissionto ExistingK&CValleySTPand Master SCADACentre (Under MIS-II contract), for this Network charges of Wireless communication systems shall be borne by the contractor only.

(b) DuringO&MPeriod:

- Contractor can Quote Network Operating charges for Wireless communication (GPRS gateway) yearly wise.

Issueof CompletionCertificateforOperationandMaintenance

TheEmployershallissueaCompletionCertificatefor“OperationandMaintenance”after successful completion of O&M by Contractor to the satisfaction of the Employer.

EndofPart16

PART17

HANDINGOVER

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PART 17 HANDINGOVER

GENERAL

This section applies to procedure(s) on handing over the works and sites related to IntermediateSewagePumpingStationbacktotheEmployerattheendof5yearsperiod of operation and maintenance by the Contractor. This shall include all civil structures, mechanical systems including pumping main system, the instrumentation/control & automation system, communication system, electrical system including 11 kV/0.433kV substations, HMI systems, all ancillary buildings and campus area.

The procedure for Handing Over shall include the final examination/tests of the system bytheEngineer.O&MContractCompletionCertificateshallbeissuedbytheEmployer after the successful final examination/tests and submission of the relevant documents.

DUTIESANDRESPONSIBILITIES

1) Allcostfortheexamination,testsandpreparationofanydocumentsofthe activities shall be the Contractor’s responsibility.

2) The Contractor shall provide all necessary labour, materials, and fuel required for tests.

3) ConductJointInspectionPriortoContract Completion:
ToverifytheconditionofWorks/ Facilitiesattheendof5yearsofoperationand maintenance for identifying damaged works, replacements and other works to be carried out tosatisfytherequirements of Operation and Maintenance Plan, ajoint inspection will be carried out by the Engineer, Employer and contractor.

4) ConductTestspriortoContract Completion:
To verify the plant condition and performance of plants including pumps, valves, gates, cranes and other equipment at the end of 5 years of operation and maintenance, Contractor shall conduct all the required Tests prior to Contract Completion.Thecontractorisresponsibletoconductannualinspectionsofcranes & other lifting equipment and other equipment as required by law/Govt. Of Karnataka.

TheinspectionitemsaregivenbelowinTable17.1butnotlimitedto this.

Table17.1:ItemstobeexaminedattheEndof5YearsO&MPeriod

Items	Description
1.Appearance test /Visual examination (Damage/crack,differentialsettlement, soil settlement, peel off painting, missing/lost, leakage of water, corrosion,conditionofstructures, others)	- All Civil structures, building including interior/exterior, fence/gate, stairs, others - AllMechanical&Electricalequipment/ accessories, others - AllPipelinevalvesandgates, others - AllInstrumentationandControlequipment,others
2.Performanceexamination (Selectionofoperationmode, selectionoffacilities,flow/ waterlevel, overflow, vibration/noise level, speed of pump/motor, smoothness, gap/spaces, accuracy, setting value, condition of structures, others)	- CheckSequence,orManualoperationincludingwater level, pressure sensors/protections, others - Check specification of all Mechanical equipment including pressure and water level gauges, pressure relief valves, others - CheckspecificationofallElectrical equipment,others - CheckspecificationofallPipelineincludingvalves, gates, others - CheckspecificationsofallInstrumentationandControl equipment, others - Checkspecificationofallaccrualconditionaftertroubleshooting, others - Performancetestsofpumpsandotherequipment
3.Verification of rectified works (System,leakage,crack,damage,soil settlement, corrosion, others)	- Checkalistofalldefectitems,history,tendency, repeating, others - Checkalistofallmissoperationandmaintenance items, others - Checkallfactorsofdefect/missoperation, others - Verificationofactiononthetakemeasures,others - Verification of allrectifiedworks withthereports and photo, others - Checkemergencyworksanditsfactor,action plan, others - Checkactualconditionafterrectifiedworks,others
4.Operationskill (Staffmember,others)	- ReviewofsummaryreportsonO&Mactivities - Checktimeandmotionofstaffmember, others - Interviewoperatorregardingtroubleshooting,others - Papertest(basicknowledge,safety,others) - Fieldtest(using/putonthesafetygear, others)
5.O/M Record	Checkinventorylist(parts,others) - Checkthequantityofinventory,others - Checkmaintenancetoolsandequipment, vehicle, others
7.Sparepartsandothers	- Checkinventorylist(parts,consumables&others) - Checkthequantityofinventory, others - Checkmaintenancetoolsandequipment,

	vehicle, others

5) SubmissionofthereportoncompletionofO&M Contract:
TheContractorshallsubmitthecompletionreportafterpassthefinal examination/tests.
The report shall consist of relevant documents, for request for issue the
Completioncertificateof5yearsO&Mperiod,whichisgivenbelowinTable17.2 but not limited to this.

Table17.2:DocumentstobehandedoverattheEndof5YearsO&MPeriod

Contents	Description
1. Outline	Outline - Summary of project, scope of work, location of project, main component with specification, others
2.CompletionPhotographs (At acceptance complete inspection, completion inspection and final inspection)	Photographswithshortdescription - Civil(structural,buildings,others) - Mechanical,ElectricalandI&C(equipment,facility,others) - Piping works
3.Inspectionsummary (At acceptance complete inspection, completion inspection and final inspection)	Appearancetest/Visual/Performanceexamination - TableofSummaryoftestactivitybasedondailyandmonthly - Listoftypeoftest,date,inspector,evaluation, comments - Civil(nameofstructure,drawingno.,drawings,design dimension, previous dimension, actual dimension, others) - Mechanical (name of facility and equipment, tag no., quantity, others) - Electrical (name of facility and equipment, tag no., quantity,others) - Instrumentation and Control (name of facility and equipment, tag no., quantity, others)
4.Maininspectiondata (At construction)	Summaryofdatawithgraphic/chart - Civil(plateloadbearingtest,compressivestrengthtest,water retainingtest,compactionfieldtest,roadconstructionworks, hydrostatic test, others) - Mechanical(disinfectiontest,others) - Electrical(earthingresistancetest,others) - InstrumentationandControl
5.Inspectionrecord (At acceptance complete inspection, completion inspectionand final inspection)	Appearancetest/Visual/Performanceexamination/ Verification of rectified works - Civil(RefertoTable17.1,pointno.1,2,3) - Mechanical(RefertoTable17.1,pointno.1,2,3) - Electrical(RefertoTable17.1,pointno.1,2,3) - InstrumentationandControl(RefertoTable17.1,pointno.1,2,3)
6.Trainingandcommission	- Summary (Schedule of training

ing record (At first and second training program)	and commissioning, attendance rate, impression on training program) - Trainingattendancelist(participants,trainingsdate,others) - Commissioning daily record (Sewage flow rate of designed andactual,nameofoperatedfacility,listofmeasurement

Contents	Description
	anditstimeandreadingvalue,valueofV/A/ kWofeach equipment, others) - Photographswithshortdescription
8.OperationandMaintenance manual(Civil,Mechanical, Electrical and Instrumentation&Control)	UpdatedO&M Manual
9.O/Mrecords	-ListofO/Mrecord,Ledgerandoperationrecord -Various types of Ledgers and other plant organizationcharts andplantmanagementrecordsincludingcostandexpenditure -Historyoftroubleshooting -O/Mrecordofaequipment - Mechanical (name of parts, tagno., quantity, location of stock, others) - Electrical (name of parts, tag no., quantity, location of stock, others) - Pipes & fittings (name of parts, tag no., quantity, location ofstock, others) - Valve& Gates (nameof parts,tag no.,quantity,locationof stock, others) - Instrumentation&Control(nameofparts,tagno.,quantity, location of stock, others) - Others(nameofparts,tagno.,quantity,locationofstock, others)
10.Sparepartslist	- Mechanical (name of parts, tagno., quantity, location of stock, others) - Electrical (name of parts, tag no., quantity, location of stock, others) - Pipes & fittings (name of parts, tag no., quantity, location ofstock, others) - Valve& Gates (nameof parts,tag no.,quantity,locationof stock, others) - Instrumentation&Control(nameofparts,tagno.,quantity, location of stock, others) -Safetyequipmentanddevicesincludingforstaffandfortesting - Others(nameofparts,tagno.,quantity,locationofstock, others)
11.Keylistwith boxes	- Name of key, location, tag no., quantity, Civil (all related material: reinforcement bar, cement, aggregate, sand, gravel, asphalt, crashed stone, chemical admixture, water reducing agent, pozzolana, water-tightness sheet, construction equipment, manhole, water-resistant coating, paint, windows, door, others) - Mechanical (all related equipment; screens, pumps, conveyor, hopper, pipes, valves, gates, pressure gauges, safety valves, safety equipment, flow meters, coating, painting, others) - Electrical (all related equipment: electrical wire,

	electrical conduit, motor, control panel, relay, transformer, heater, generatorandsilencer,timer,breaker,light/lamp,switch, street light, earthing, measurement equipment, air condition, communicationequipment,electricpole,coatingpainting,

Contents	Description
	ventilationfan,airduct, others) - Instrumentation&Control(allrelatedequipment,others) - Safetyequipment - Others
12. Manufactureproduced catalogue (Civil,Mechanical, Electrical and Instrumentation&Control)	- Civil (all related material: reinforcement bar, cement, aggregate, sand, gravel, asphalt, crashed stone, chemical admixture, water reducing agent, pozzolana, water-tightness sheet, construction equipment, manhole, water-resistant coating, paint, windows, door, others) - Mechanical (all related equipment; screens, pumps, pipes, valves, gates, pressure gauges, safety valves, safetyequipment, flow meters, coating, painting, others) - Electrical (all related equipment: electrical wire, electrical conduit, motor, control panel, relay, transformer, heater, generator and silencer, timer, breaker, light/lamp, switch,street light, earthing, measurement equipment, air condition, communication equipment, electric pole, coating painting, ventilation fan, air duct, others) - Instrumentation&Control(allrelatedequipment,others) - Safetyequipment - Others
13.Instructionmanual(Civil, Mechanical,Electrical and Instrumentation&Control)	-Seeabove (11)
14. Factory inspection recordorQualityassurance(Civil, Mechanical, Electrical and Instrumentation&Control)	- Civil (all related material: reinforcement bar, cement, aggregate, sand, gravel, asphalt, crashed stone, chemical admixture, water reducing agent, pozzolana, water-tightness sheet, construction equipment, manhole, water-resistant coating, paint, windows, door, others) - Mechanical (all related equipment; screens, pumps, pipes, valves, gates, pressure gauges, safety valves, safetyequipment, flow meters, coating, painting, others) - Electrical (all related equipment: electrical wire, electrical conduit, motor, control panel, relay, transformer, heater, generator and silencer, timer, breaker, light/lamp, switch,street light, earthing, measurement equipment, air condition, communication equipment, electric pole, coating painting, ventilation fan, air duct, others) - Instrumentation&Control(allrelatedequipment,others) - Safetyequipment - Others
15.Photograph (During Construction, at defect liability, at	History of construction Replacementofdefectliability - Civil: construction site before starting

joint completion inspection) (Civil, Mechanical, Electrical, Instrumentation & Control)	construction, earthwork, arrangement of bar, cleaning before placing, formwork, concrete mixing work, placing, vibrating, curing, remove of formwork, backfill, compaction, all fieldinspection and lab test, others - Mechanical: inspection at factory, receiving inspection, completioninspection,allfieldinspectionandlab.test,others - Electrical: inspection at factory, receiving inspection, completioninspection,allfieldinspectionandlab.test,others

Contents	Description
	- InstrumentationandControl:inspectionatfactory ,receiving inspection, completion inspection, all field inspection and lab. test, others
16. Production samples (Civil,Mechanical, and Instrumentation&Control)	Allsamplesfortechnicalapproval - AttachAnalyticalinstrumentsname,approvedsignofthe Engineer.
17. Report	- MonthlyandAnnualreport - Others

Thesedatashallbeprovidedbothinsoftandhardcopies,inproperprofessionalformat.

SPECIFICATIONS

Thespecificationofmaterialsusedforrepairsshallbethesameashavebeen usedinthe original work. Specifications for any materials whichwere not used duringconstruction shall be approved by the Engineer prior to Handing Over.

CHECKLIST

GENERAL

Within the framework of the Contractor's responsibilities given above, the Contractor shallcarryoutthefollowingactivities.However,theseshallnotlimitthereq uirementfor other activities which otherwise are required as per terms and conditions of the Contract or to fulfill the Contractor's responsibilities or are essential as per good industrial practices. The Contractor shall hand over all the components of works in good working condition for the following, but not limited to:

a) Allpumps,motorsandothermechanicalequipmentetc.,attheInterme diateSewage Pumping Station (all works constructed in this Contract).

b) Allrequiredconsumablesrequiredforfunctioningofplantwithi nventoryof material.

c) All Electrical Equipments such as Transformers,11kV Metal Enclosed Switchboards&Switchgears, 415V metal enclosedswitchgears(PCC)/MCC,415 VPowercapacitorandcontrolpanel,DieselStandbyGeneratorwithA MFControl Panel and Synchronizing panel, Battery, battery charger and DC Distribution Board, Variable Frequency Drives, Non Segregated Bus Duct, Power & control cables, Cable carrier

system, Lighting system , Earthing and lightning protection systems ofthe Plant (All works constructed in this Contract).

d) AllInstrumentationandcontrolequipment etc.,atthepumpingstations(Allworks constructed in this Contract).

e) Administrativebuildingsetc.atthepumpingstations(Allworksconstructedinthis Contract) in neat and clean condition.

f) AMC contracts with system / equipment suppliers, as necessary for PLC system supplierortheauthorizedsystemintegratorasexecutedtheworkforthisproject.

g) Lightingfixturesandthelightingsystemofallareasandreplacement ofall non- functional lighting fixtures.

h) Recordsforthefollowingsbutnotlimited to
   - Repair history of all mechanical, electrical and instrumentation control equipmentinIntermediateSewagePumpingStation,andcommunication instruments;
   - LogbooksthroughPLCsystem;
   - Dailylogofoperationsofalltheimportantequipmentwithtimetag;
   - Hourlyreadingsofwaterlevels,pressuresensors,flowratesandintegrated quantity of water;
   - Operationalcost;
   - MonthlyRunninghoursoftheallMechanicalequipmentandtotalelectrical power consumption;
   - Screeningshandlingamount
   - Dailylistofalarmswithtimetag;(Powerconsumptionbyeach Pump)
   - Logbookformatandthedatatobeincludedinthelogbook;
   - Lastperiodicmaintenancedoneforallequipment/buildingsofthesystem;

i) Required spares, generaland special tools &tackles,test equipment and adequate inventory of required accessories or equipment itself for repair/replacement of defectiveelectrical,mechanical,instrumentationandcontrolsystem,pipe,andthe communication system. However at the end of the Contract, the Contractor shall hand over the full spares, tools and tackles as supplied with the Contract by replacing the used items with fresh supplies of the same specifications.

j) Repairoftheroads,buildingsandcampusarea utilities.

k) Drinkingwatersupplyfacilitiesatsewagepumpingstationandallits units.

l) Record of stores for the electrical, mechanical and instrumentation and control equipmentaswellasthatforconsumables.Therecordswillincludebutshallnot be limited to:
   - Materialsreceivedandissuedforworks;
   - Properarrangementofmaterialinstorestoensureitssafetyandeasy availability;
   - Maintainingstoreareasinaneatandtidycondition;
   - Keepingrecordsandaccountingfortheincomingmaterials,
   - Keepingrecordsandaccountingfortheconsumedmaterials.

m) Structures/

buildingsofcampusareasofIntermediateSewagePumpingStationa
nd others built in the Contract must ensure adequate
cleanliness, ventilation, illumination and structural safety. In
addition to this, the general hygienic

standardsmustbeinacceptableconditionandadequateplantation ;horticultural activitiesmustbewellmaintainedtogivepleasantenvironmentoft hecampus/ building.

n) Updatedoperationandmaintenancemanualasdefinedinspecificati onsforO&M works.

m)6setsofHardCopiesand2setsofSoftcopiesofall“AsCommissionedFina l Drawings”.

INTERMEDIATESEWAGEPUMPINGSTATION

TheContractorshallhandoverallcomponentsoftheworksingoodworking condition for the following, but not limited to:

i) All facilities from inlet gate/valve to wet well, to pumps, motors, valves, cranes, flowmeters,compressorroom,PLCcontrol,Transformers,11kVMet alEnclosed Switchboards & Switchgears, 415 V metal enclosed switchgears (PCC) /MCC, 415 V Power capacitor and control panel, Battery, battery charger and DC Distribution Board, Non Segregated Bus Duct, Power & control cables, Cable carriersystem,Lightingsystem, Earthingandlightningprotectionsystems ofthe Intermediate Sewage Pumping Station (All works constructed in this Contract).

ii) PLC,includingthehardware,softwareandallinstruments,ingo odworking condition**.**

iii) Entirecontrolsystemandinstrumentsasperthecontractandma nufacturer’s recommendations.

v) Replacementofdamagedcontrols,communicationcablesandp owersupply cables.

vi) Repairorreplacement,asrequired,ofallinstrumentssuchasflowmet ers,pressure transmitters, pressure gauges, level sensors/transmitters, float type level switches along with all other equipment.

vii) Calibration of all measuring/metering equipment or as recommended by the manufacturer.Thecalibrationatmanufacturer’sworksshallbedo neincaseof major failure/ repairs of the instruments.

viii) Deleted

ix) Toprovideallrequiredconsumablesforaperiodof–12 months.

x) Repair of damaged moving parts, steel structures, and the RCC structure. Subsequentlytherepairs,cleaningdisinfectionandpaintingofallcivil worksmust have been done.

xi) Lubricationofallgears,motors,motorizedvalves,gatesandother partsofthe system.

xii) Check all valves and gates for their manual and electric operation. Operation of valvesmustbecheckedfromlocalcontrolconsole,switchgearandthroughPLC system. Any defect observed must be made good.

xiii) Makegoodallcircuitsandbuildings,allelectrical,mechanicalandinstrumentation equipment, substation equipment, lighting, DG Set and earthing system associated including replacement, if any (as required).

xiv) Paintingoftheexposedmildsteelcomponentsofpipeline,ladders,railingsetc. must be done.

xv) Makegoodlandscapingofthesurroundingareasofthepumpingstation,freefrom shrubs, weeds, grass and other unwanted vegetation.

xvi) Ensuresafetyaccessories,e.g.gloves,shoes,firstaidbox,etc.

xviii)Ensuringfireandsafetyequipment.

LUBRICATION

TheContractor,intheoperationandmaintenancemanuals,shallfurnishacomplete schedule of recommended oils, grease, and other required lubricants.

The Contractor shall indicate the brand name of indigenously available equivalent lubricants,withtheircompletedutyspecifications,intheO&Mmanual.TheContractor shall alsofurnishthescheduleofquantitiesforeachfill,frequencyoffillingandannual requirement in O&M manual.

Wherelubricationiseffectedbymeansofgrease,preferenceshallbegiventoapressure system which does not require frequent adjustment or recharging. Frequent, for this purpose, means more thanoncein a month.Where more than one type of specialgrease is required, a grease gun for each special type shall be provided for the usage.

SPAREPARTS

Allsparepartsusedfortheequipmentinthemaintenanceofthesystemmust befromthe manufacturer of the equipment or, if the equipment itself has been made with parts from other manufacturers, the parts must be of the same make as used in the equipment supplied and installed.

All spare parts shall be packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be labeled on the outside of its packing with its

description,numberandpurposeand,ifmorethanonespareispackedinasinglecase,a general description of the case contents shall be shown on the outside and a packing list enclosed.

ELECTRICALSYSTEM

TheContractorshallhandoverthefollowingattheendofOperationandMaintenance Period:

(i) Revised as built drawings based on all modifications during O&M Period. All Electrical Drawings like Single Line Diagrams, Control Circuits Equipment Layout, Cable Layout, and Cable Schedules, Lighting Layouts, Earthing Layouts etc., should be maintained and handed over.

(ii) Details of Protective Relay Settings and time relay settings including any changes doneduringtheOperationandMaintenanceperiod,DetailsofOilChanges /Filtration ofTransformers,Records of anychanges made inthe Systemduringthe Operation and Maintenance period etc should be maintained.

(iii) Equipmentwisemaintenancerecordduring O&MPeriod,asperdaily checking out/inspection and regular (every 6 months or 12 months).

(iv) Motor wise Power consumption Details and over all power consumption detail of plant.

(v) DetailsofIRTestofallEquipmentslike,HT/ LTSwitchgearPanels,DieselGenerators, Transformers and Cables etc should be maintained.

(vi) LogbookshowingdetailsElectricalfaultsthathaveoccurredintheplantand record of corrective actions taken during O&M period.

(vii) Equipment wise technical data given by equipment supplier, Documents showing Bill of Materials and Operation & Maintenance Manual (hard copy or soft copy).

(viii) Listofmandatoryspareshataretobemaintainedatstoresandtheiractual availability in plant, if it is below same has to be replenished.

(ix) DetailsofMeasurementofEarthresistance,EarthPitwiseandOverall Values during the O&M Period.

(x) DetailsofIlluminationLevelsduringtheO&MPeriodalongwithdetailsof changes, if any effected during the O&M period.

ELECTRICALCHECKSTOBEDONEDURINGHANDOVERAFTERO&M PERIOD

(i) Contractor to provide a test schedule & format to be approved by engineer before commencing any test.

(ii) Checkingofallelectricalequipment,itemsetcasperbillofmaterials.Vi

sual checking and tracing out the circuit based on revised as built drawings.

(iii) PhysicalOperationalchecksofallEquipment&Protectionshavetobedone.

(iv) Power frequencyvoltage tests &IR measurement forvarious electricalequipment, items& cables to be done.

(v) Testingoftransformeroil samples.

(vi) Measurement of earth resistance for individual earthing system & overall for theinstallation.

(vii) CheckingofLightningProtectionSystem.

(viii) Measurementofilluminationlevelatvariouspremises.

(ix) Ifany item isfoundtobe faulty during theabovechecks/teststhesameshallbe rectified/replaced as necessary.

INSTRUMENTATION,CONTROLANDAUTOMATIONSYSTEM

TheContractorshallhandoverthefollowingdocuments/manuals/ programsattheendof Operation and Maintenance Period for ISPS under this contract:

i. Detailed drawings and O&M manuals of all the Instruments, Panels, Valve Actuators, Field Instruments etc supplied under IC&A package of the contract.

ii. Detailed drawing and manual of the PLC installed. Manual shall include the PLC seriesinstalledalongwithcompletedetailsonI/Omodules,Ethernets witch,Relay modules, and converters (if any).

iii. A complete manual shall be provided which shall include operating instructions and troubleshooting techniques of the PLC and accessories installed illustratedwith examples. This shall be provided along with the standard manufacturer’s literature.

iv. A complete manual shall be provided which shall include operating instructions and troubleshooting techniques of the interface control panel to Master SCADA Centre, illustrated with examples. This shall be provided along with the standard manufacturer’s literature.

v. Interoperability testing tool/software shall be provided along with relevantmanuals and operating instruction with examples.

vi. Latest PLC program back-up, HMI software back-up with license, HMI database backup, reports and alarmback-up, Historical archived data containingreports and alarms and configuration set-up shall be provided.

vii. All software’s used under ICA shall be handed over along with their original licenses.

viii. Complete list of database /addresses shall be provided clearly indicating the spare tags for PLC & HMI software.

ix. List of mandatory spares that are to be maintained at stores for complete ICA package and their actual availability in plant, has to be provided.

x. Any password's set to access the internal PLC program; interface control panel shall be provided and demonstrated.

xi. All passwords (PLC, Interface control panel & HMI and other software/hardware) shall be provided in a sealed envelope and addressed to the Chief Engineer (K).

xii. PLC, HMI package shall be updated with the latest software version/ patch before handing over. The same has to be demonstrated to the engineer.

xiii. Latest licensed version of windows operating system along with MS–Office or equivalent software which is prevailing at that point of time shall be installed on HMI machines and other machines installed and integrated with the HMI package. The same shall be demonstrated to the engineer.

xiv. Contractor shall conduct an adequate training session for the client's staff which shall include PLC configuration, trouble shooting techniques, HMI configuration and trouble shooting techniques, diagnostic techniques and trouble shooting techniques for wireless technology employed for communication.

xv. The training session shall be of duration of minimum Five (5) working days at a stretch.

xvi. Manufacturer's literature/Manuals shall be furnished for flow meters, level transmitters, switches, pressure transmitters etc ...,

xvii. Instrument wise, PLC and HMI wise maintenance records of complete O&M period shall be provided.

xviii. A complete and updated list of all manufacturers/system integrators/contractors of ICA with contact numbers shall be provided. The same shall also be made available on site for ready reference.

xix. The final as commissioned versions of all drawings of ICA, which will include cable termination details, I/O mapping, database details etc shall be provided in PDF format and editable format and loaded in the operator machine available on site. The same shall be demonstrated to the engineer.

ICACHECKSTOBEDONEDURINGHANDOVERAFTERO&MPERIOD FOR ISPS UNDER THIS CONTRACT

(i) Contractor to provide a test schedule and format to be approved by the engineerbefore commencing any of the tests.

(ii) FunctionalCheckingofallICAequipmentincludingflowmeters,pressureand level instruments, and wireless equipment being used for

communication.

(iii) Loopcheckswill beconducted.

(iv) All instrument cabling shall be inspected for continuity. If found faulty, the same shall be replaced and demonstrated.

(v) All instrumentation cable conduits shall bechecked for damage. If found faulty,they should be rectified or replaced and sealed to the satisfaction of the engineer

(vi) Visual operational checks of all the Panels including PLC panel, HMI system, and interface control panel.

(vii) LicensingfeatureofPLCsoftwareandhardwareshallbe demonstrated.

(viii) Functional check of set points change at HMI and it's downloading to PLC's concerned.

(ix) Standalone diagnostic features of PLC and I/O modules shall be demonstrated. If found to be faulty/non-operational, shall be rectified and if required replaced to normal working condition and demonstrated to the client.

(x) HMIshall bedemonstrated.If foundtobefaulty/non-operational,shall berectified and if required replaced to normal working condition and demonstrated to the client.

(xi) Functional check of data received/transmitted from remote stations shall be conducted in conjunction with HMI.

(xii) Functional check of interface control panel to HMI system in conjunction with Master SCADA Centre (under MIS-II contract) shall be conducted.

(xiii) Historicalarchivingofalldatashallbedemonstrated.

(xiv) Availability of memory for smooth operation of PLC, HMI machines shall be demonstrated. If found to be in-adequate, the same shall be rectified /archived and demonstrated.

(xv) If any instruments and automation equipment are found to be faulty during the above tests, the same shall be rectified or replaced as necessary.

ANCILLARYWORKS

(i) Make gardens and plantation in the campus area green, neat and tidy with removal of shrubs, weeds, grass and unwanted vegetation and make pruning, trimming and cutting of old big trees from the Plant Area along with.

(ii) Reinstate the roads and lighting fixtures and lighting circuits in campus to it original state.

(iii) Make good and in working condition for lighting fixtures and lighting circuits, water supply facilities in Sewage Pumping Station, offices and other buildings.

(iv) The Contractor shall carry out ordinary repairs to buildings. The repairs may include but not limited to the following items:

  (a) Easingofdoorsandwindows,monsoonrepairstoroofs,attentiontodrains, rain water spouts, attention to plinth protection.

  (b) Externalwhiteorcolorwash,externalorinternalpainting,internal distempering, renewal of approach roads

within the campus.

(v) Any faults in the electric installation, leakages, earthing, exposed wire ends and anyhazardsonthisaccounttotheusers/inmatesofthebuildings,should betaken care of suitably, wiring, which is damaged or outlived, should be replaced.

(vi) Damagedsanitarylinesshouldbereplacedandchokedlines cleared.

(vii) Proper drainage of the area around the building should be ensured to avoid stagnation of rain water/ house effluent, in order to prevent malarial conditions. Wherecourtyardsexistinthebuildings,theirdrainageintotheouterdrainsshould be ensured. Any choked drains should be cleared properly.

(viii) Leakingroofs should be attendedto immediatelywithsuitable repairs/ treatment, asthecasemaybe.Therainwaterspoutsshouldalsobeclearedofblockages,etc. The roof should be swept clean of leaves, debris, etc., if any.

(ix) Theplaster onouter wallsofthebuilding,whichisexposedtoweather,shouldbe repairedbeforerainsinordertopreventdampnessinside.Whereplinthprotection has been provided, it should be checked and the damaged portions, if any, should be repaired before rains.

(x) Damagedflooringshouldberepaired/ replacedasperrequirement,inorderto prevent dampness inside the rooms, etc. during rains.

(xi) Repairs of damaged floors, door/window fittings, water taps, water coolers, furniture,desertcoolers,electriccircuits,mustbetakenuponcomplaintsusingthe material of same quality as used during construction.

(xii) PumpHouseventilationsystemtobecheckedforeffectiveheatdissipationfrom the Pump Motors and Electrical Equipments.

WIRELESSCOMMUNICATIONSYSTEM

(i) Make good a wireless communication system to ensure reliable and easy communication to and from ISPS and Master SCADA control center (Under CP- 24 contract) and also Existing K&C Valley STP.

(ii) Replacement of batteries, faulty sets and all other non-functional equipment to ensure trouble free communication if required.

COMPLETIONDOCUMENTS

Completion (Handing over) documents shall include on a minimum 3 sets of softcopies and 3 sets of hard copies. The hard copies shall be spiral bounded clearly indicating the version/revisionsubmitted.Allthecontentsshallbeindexed.Thecontentsofcompletion documents shall be clearlylegible and shall include original manufacturer’s literature on a minimum, and in-corporate any changes as per site conditions.

The comprehensive updated operation and maintenance manuals (six sets) shall be submittedattheendoftheoperationandmaintenanceperiod.Itshallbeupdated based on the principals broadly listed in Part-16.

AS-BUILTDRAWINGS

Revised As-built drawings based on all modifications during O&M Period shall be submittedattheendofO&Mperiod.ItshallincludealldrawingsofISPSunits (planand all necessary sections), utility and ancillary buildings, site layout pumping station, drawingofpumphouse,layoutofpumpsandallothermechanicalequipmentandpiping, all electrical drawings like Single Line Diagrams, Schematic Diagrams, Control Circuits Equipment Layout, Cable Layout& Cable Schedules, Earthing Layouts and all ICA Drawings like P&ID, System configuration diagram (PLC & HMI architecture), Instrument installation drawings, Instrument cable schedule, and cable layouts. Six sets of the revised as-built drawings shall be submittedin hardcopies andsoftcopies (editable form).

PRICES

The Contractor, at the time of bidding, will be responsible to ensure the completeness andadequacyofhisBidPricetofulfilltheentireresponsibilitiesasdescribedabove.His bidprice,asquotedonayearlybasisintheScheduleofPrices,shall includeallcostsfor handing over.

NOTUSED

COMPLETIONCERTIFICATEFORO&MCONTRACT

1. The Contractor on completion of O&M period will request the Employer for a joint inspection of the Plant, after ensuring that all the Plant equipments are in good handing over condition and all the requirements/documents as specified in this contract are also ready for handing over.
2. Based on above request a Joint Inspection with Engineer shall be arranged by the Contractor to assess the condition of civil

structure, mechanical, electrical and instrumentation equipment and First Joint Inspection Report**,** for various required remedial actions, repair actions, replacement actions, tests etc. shall be prepared.

3. The Contractor shall attend to all points of Joint Inspection Report, by carrying out all such remedial/repair/replacement actions, tests at his own cost, and after attending, will confirm the same to the Employer.
4. On receipt of the confirmation as above 3, Second Joint Inspection shall be arranged by the Contractor, for certification of completeness of remedial work, as well as condition of all civil works to its original appearance.
5. The Contractor shall submit the entire required documents to Employer for review and comments. The Contractor shall resubmit the documents incorporating the comments.
6. The Employer shall issue the Completion Certificate of the O&M Contract to the Contractor within 30 days of acceptance of Second Joint Inspection Report, subjectto the above documents and obligation are met by the Contractor before 90 daysprior to handing over of the plant.

EndofPart17